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EDITORIAL NOTES.

THE sailing of the reconstructed *Viking* ship across the Atlantic in May promises to be of far more value and to possess a scientific interest that has not yet been touched by the foolhardy voyages in dories. The vessel has been built upon the lines of the original ship unearthed at Sandefjord, and is 17½ ft. long, with a beam of 16¼ ft.

SLOWLY we are coming up to do some things that they are doing abroad. Hydraulic machinery has received a wide application in London and Liverpool for years. Pneumatic tubes are used for the transmission of parcels in every capital of Europe; and now we learn that a large manufacturing house is about to put a complete line of high-speed hydraulic motors upon the market, while successful experiments have been conducted with a pneumatic tube service in Philadelphia.

THE report of the board appointed to test the guns of the *Vesuvius* appears in another column, and practically bears out the criticism of the work done which appeared in our March issue. It says, in substance, that while the accuracy of aim was satisfactory, and it has been proven possible to fire dynamite in the manner proposed with safety to the crew, the details of the mechanism need some modification and the fuse is inadequate for the work required of it. In short, that the *Vesuvius* can probably be made effective by the expenditure of more time and money, but that at present the craft is not all that is to be desired.

THE rapid development of electric railroading within the past few years has led to their extension in such a way as to make them competitors of the steam roads in some localities. And now the New Hampshire Commissioners present a protest against the granting of franchises to electric roads for the right to use the public highways, on the ground that the steam corporations, with whom the electric road enters into competition, is required to, buy its right of way, construct and maintain its roadbed, bridges, and fences, and there is no good reason why the competitor, whose business is exactly the same, should be given a roadway and furnished with a roadbed, bridges, and fences at the public expense.

THE COMFORTS OF RAILROAD TRAVEL.

ABOUT two years ago an editorial article on the Discomforts of Railroad Travel was published in THE RAILROAD AND ENGINEERING JOURNAL. The *raison d'être* or reason for existence of that editorial was stated in the following introduction, which has probably been forgotten by most of those who read it, and will be new to those who did not, and may therefore serve again as a preface to what will follow here. The prefatory observations were as follows:

In an admirable essay on Organization in Daily Life, the author, Sir Arthur Helps, said:

If you want to improve the administration of railways, I will tell you how to do it. Look out for a very ingenious, sickly man, with a large family, and give him $4,000 a year as an inspector of railways. Let him make short reports, in good English, of his sufferings on different railways, specifying names, dates, and every particular. He must be bound to travel occasionally with his whole family, in the depth of the winter. We do not know of their sufferings sufficiently in detail. An ordinary person would be ashamed to describe these minutiæ; but it must be this man's business. Besides, seriously speaking, he would meet with great differences of treatment. One thing is well managed on this railway, another on that. He would be able to praise as well as to blame. There is one railway I know of on which, to my judgment, the coupling of the carriages is not sufficiently attended to. There is another railway on which I have never found the same fault. My inspector would tell the world these things, and an effect would be produced upon the traffic of these lines.

Probably few of the subscribers of this JOURNAL will read the above suggestion without feeling a desire to be appointed such an inspector, not alone for the salary of $4,000, but from a sort of instinct of reform which most active-minded people feel, and which manifests itself in a longing to set those things right which, in their judgment, are going wrong. While such an appointment and salary would not be easy to get, any of us may indulge in the hypothetical exercise of the duties and privileges of the office, without the salary. The writer has a sufficient amount of overweening vanity to imagine that he has some of the qualifications required of such an inspector. He is sufficiently ingenious to be called a "crank," and though not exactly sickly, he has a digestive apparatus which does not consume its fuel as successfully as a locomotive with a

brick arch does. He has not a large family, but he nurtures a brood of cares, anxieties, duties and responsibilities which he takes with him in his travels, and which are, perhaps, as troublesome as a family of children would be. He can make a report in English, which competent critics would reject as a model of style, but it has the merit of being comprehensible. He therefore assumes the office of a self-appointed inspector of railroads, and submits this as his

SECOND REPORT.

Persons old enough to remember how people traveled 50 years ago and the travail attending it, and who now have occasion to take a journey on any of our main lines of railroad, cannot help but compare the discomforts of a journey in those early days with the luxuries which may be enjoyed now. Then many journeys were made with no other protection from the elements than the sky or the clouds above the traveler, and a saddle and horse below him. It is true that there were some ills about which we complain a great deal that he did not suffer from. Bad ventilation is one of these; par-boiling by steam heat, another. It is said that the best thing for the inside of a man is the outside of a horse, so that our ancient equestrian travelers' lot may not have been as bad as it now seems to us. It may be, too, that the jolting of a stage-coach had a beneficial effect on the jolted, analogous to that of the Swedish movement cure; but it would perhaps be hard to convince weary passengers of it after they had been jolted, bounced and bruised in one of the old-fashioned vehicles on a rough road for many hours.

To-day all this is changed. If we are democratic and economical, or economical without being democratic, we can have a more or less comfortable seat in a car which does not jolt disagreeably, in which we are completely protected from the elements, the vehicle is warmed more or less comfortably, and at night lighted, so that if we have good eyesight we can see to read. We have large, clear windows from which, excepting in some execrable drawing-room cars, we can "view the landscape o'er." Instead of traveling at a speed of from four to six miles an hour, we go about 10 times as fast. At night we can stiffen our backbones and wriggle into more or less uncomfortable positions and snatch such periods of slumber as may be possible under the circumstances. All that can be said, though, for this kind of rest is that it is not quite as uncomfortable as trying to sleep on horseback or in a stage-coach.

If we are not disposed to be overmuch economical, we can have greater comfort and more luxuries than an ordinary day coach affords. We may engage and pay for a berth or section in a sleeping-car, and, at night, enjoy the rest which a more or less comfortable bed will afford, and in the daytime—if we indulge in the luxury of a whole section—may have the exclusiveness which is afforded by an apartment reserved for our own use, which gives ample room for the disposal of our "traps" and for the stretching of dependent limbs. The seats are almost ideally comfortable. They are of ample width, the lower portion of the backs is curved to fit the shape of the spinal column, and the upper part is formed to support the shoulder blades. In the Wagner cars the seats are inclined backward, so that a person sitting in the seat thus occupies a static position, and is without any dynamic tendency to slide out of it. The Pullman Company does not seem to have grasped the law which governs the involuntary action of the human body when it occupies a horizontal seat, and all or nearly all the seats in its sleeping-cars are without any backward inclination.

It is said of some English statesman who was very much overworked, that when he became exhausted he would take a journey from London to Edinburg in a first-class railway carriage, as he found that nothing rested him as that did. The diversity of scene, the rapid and easy motion, the rest which was given by the pre-eminently comfortable seats in an English first-class carriage, the separation from the intrusion of letters, telegrams and bores—all conspired to retard the wheels of thought and rest the weary body. To the overworked in this country there is nothing like a day journey in a first-class sleeping-car for a temporary rest. It is to be regretted that such cars cannot be so highly recommended, and that they are much less comfortable for night travel, the purpose for which they are intended.

A little criticism—the result of observation during a recent journey—may not be inappropriate here. The "final cause," as the metaphysicians would say, of a sleeping-car is to enable people to sleep in them, one prerequisite to which is a comfortable bed. Now it is a matter of general repute, which is the result of much experience, that sleeping-car beds are not comfortable. They are generally hard, inelastic, and make one's bones ache by reason of the jolting of the car. A little analysis of their construction will show the reason for this.

What may be called the permanent way of the bed is the seat and back cushions. The former of these must support the passenger in daytime, when he is sitting upright. In this position his bearing surface on the seat is probably about one-half of a square foot. The springs and upholstery of the cushion must therefore be made stiff enough so as to support a weight of from 100 lbs. or less up to, say, 250 lbs., on a half of a square foot of its surface. At night this same cushion forms part of the substructure of the bed. In a recumbent position an occupant of a bed has about 10 times more bearing surface on it than a sitting passenger has on a seat. Consequently a seat should be about 10 times as rigid or stiff as a bed, or, conversely, the bed should be 10 times as yielding or elastic as the seat. Now, in ordinary sleeping-cars the seat cushions must do duty both in daytime and at night. From what has been said, it is obvious that it is not equally well suited for both uses. As the back cushions of seats need not support the weight of passengers for day use, they may be made much softer than the seat cushions, and in ordinary day cars they are usually made so; but in sleeping-cars they form the head or foot portion of the bed, and as the seat cushions form the middle, the backs must be made as hard as the seats, otherwise there would be a diminutive mountain in the middle of the bed, with a valley at each end. For this reason the back cushions of sleeping-cars are made nearly or quite as hard as the seats, which makes the former uncomfortable both in daytime and at night. Now what seems to be needed is a seat cushion which will be sufficiently elastic or soft to make a comfortable bed at night, and with enough rigidity to be able to support heavy passengers in daytime. Then the back cushions might also be soft, which would make them more comfortable both in daytime and at night.

These requirements for seat cushions may seem to be contradictory or incongruous. We have Herbert Spencer's authority for the statement that "all organic evolution consists in a change from the homogeneous to the heterogeneous," and that "every existing organism has been developed

out of the simple into the complex," and that the functions of organisms become "differentiated." Now, in order to solve the difficulty with the seat cushions, it is proposed to "differentiate" the functions of the seat springs. It should be kept in mind, though, that what is said here is merely suggestion, and is not offered as a complete solution of the problem. Before that stage is reached experiment, adaptation and improvement of details will be required.

The differentiation referred to is that *some* of the springs of seats should be made to carry the weight of occupants of the bed at night, and others or all should support the passengers in daytime. Supposing that the seat cushions were provided with springs whose tension when they are all compressed to a length of, say, 3 in., would be sufficient to support an occupant in a sitting posture. Suppose, further, that when the seat is upholstered every alternate spring is drawn down so as to be compressed to 3 in. in length, and that the intervening ones were permitted to extend to, say, 5 in. Now attach the surface upholstery—hair, canvas, plush, etc.—to the extended springs in such a way that they alone would at first bear the weight of a person sitting or lying on the cushion. When used as a seat the extended springs would be compressed, until they are compressed to 3 in. in length. The weight of the person sitting on the seat would then bear on the intervening springs, and it would be equally distributed on all the springs in the seat. If used as a bed, the extended springs alone would be sufficient to support that part of the weight of the sleeper which would rest on them. Another suggestion which may occur to some of our readers is to have two tiers of springs, the upper ones light and flexible and the lower ones stiffer and more rigid.

It is true that the beds in sleeping-cars always have a shallow mattress of varying degrees of softness and hardness on top of the seat and back cushions. This is nearly always insufficient to prevent the protrusion of the bones of the passenger—especially when they have been hardened by the chilling effects of some scores of winters—to the seat cushion below.

It may be added that if the seat cushions had more elasticity, those in the back could also be made more unyielding, which would make the latter more comfortable by day and also by night.

Both the Pullman and the Wagner companies have been liberal in the expenditure of money for the gratification of the public's taste for what the ladies call "elegant" upholstery and cabinet work, until the magnificence of some of their cars has become oppressive. In view of their skill and liberality in other directions, it is a matter of some surprise that they have not provided that essential for sound sleep—comfortable beds.

Another subject of general complaint is the heating of cars. With some of the systems of heating with steam from the locomotive—perhaps with all—the lower and at times the upper berths of sleeping-cars become chambers of torture. Passengers are compelled to sleep over hot steam-pipes whose temperature they cannot control, and which, apparently, is not controlled by any one else. Added to this is often impure air due to inadequate ventilation. There is either no adequate means of regulating the steam-heating apparatus and the ventilation of the cars, or the attendants do not know how or are indifferent about using the means of regulation. Of late years we have heard a great deal about color-blindness. Apparently many of the attendants of sleeping and other cars are blind in their noses, and have little or no sense of temperature. They are also very ignorant usually about the properties and quality of air. It is almost impossible to make an ordinary sleeping-car porter—or, for that matter, an average passenger—comprehend that air which is cold may also be impure. Hotness and coldness are the only two properties which they seem to think air can have. Even in the matter of temperature their senses are usually very obtuse. They do not seem able to discern any difference less than from 40° to 50°. They seldom discover that a car is getting too cold until its temperature gets down to about 40°, nor do they find out that it is too warm until it reaches about 90°. As for impurities in air, most of them do not seem to comprehend that there is any such thing.

Inasmuch as the comfort and to a considerable extent the health of passengers in sleeping-cars is in charge of their attendants, it would seem worth while that those in control should learn something of the capacity of their employés for their duties. It would be interesting and curious, and probably advantageous, to the traveling public if applicants fo employment as porters and conductors of sleeping and drawing-room cars and brakemen of passenger trains were subjected to a sort of car-service examination. Among the questions which might be asked would be such as the following:

1. Can you smell?

(Then the candidate's sense of smell should be tested by trying whether he could distinguish the odor of well-known substances, as camphor, turpentine, kerosene, whiskey, peppermint, Limburger cheese, etc., in weak solutions.)

2. Can you feel the difference between warm and cold objects?

(A test of the sense of feeling should then follow by having the applicant put his hand in basins of water of different temperatures.)

3. Do you know what a thermometer is?
4. What is it for, and what does it show?
5. How warm should a room or a car be, in winter, to be comfortable?
6. At what temperature does a car become too warm, and at what too cold?
7. If a car was too cold in winter, what would you do?
8. If it was too warm, what should be done?
9. If the air smells bad, how can it be made pure?
10. If you opened all the ventilators and the car then became too cold, what would you do?
11. If you closed them all and it then began to smell bad, what ought to be done?

(If in reply to the two last questions the examinee should not suggest that *some* and not *all* of the ventilators might be opened or closed, he should be remanded for further instructions. It never seems to occur to porters or brakemen that *some* of the ventilators in a car may be either opened or closed. They either open *all* of them or shut *all.*)

12. Is impure or foul air always warm?
13. Is cold air ever foul?
14. Does cold air ever smell bad?
15. To keep the air in a car pure, what must be done?
16. Do you use tobacco or chewing-gum?
17. How often do you take a bath?

Other questions might, of course, be asked to advantage, and the catechism of car service could be much extended. The above interrogations are merely suggestions. Such an

examination would certainly have the effect of stimulating candidates to inform themselves about subjects which their duties seem to demand they should have some knowledge of.

Another deficiency in sleeping-cars is the want of some suitable place for locking up one's valuables. Every one feels more or less nervous about going to sleep in a car with a valuable watch or jewelry and a considerable amount of money or maybe important papers or documents on his person.

It is curious to notice, too, what a strong hold on all men habit has. We go in certain beaten paths which are well worn, and only very strong influences seem to divert most people from them. Mere deductive reasoning seldom seems to be sufficient to divert people from the road which is trodden into ways of rationality. The special instance which has called forth these remarks is the height of the arm-rests of car seats. With the old method of reversing the backs of seats it was essential to place the pivots of the reversing arms about 8 or 9 in. above the seats. This required that the arm-rests should be from 10 to 12 in. higher than the seat. Consequently to rest the arm on it, it was necessary to "hunch" up the shoulder into a most uncomfortable position. As the demands of the mechanism for reversing seat backs required this height, it had to be submitted to. When drawing-room car chairs were introduced, it was soon observed that their comfort was materially improved by lowering the arm-rests, and they are now seldom made more than 6 or 8 in. high above the seat. Notwithstanding the fact that the improved mechanisms for reversing seats no longer require so great a height of arm-rest, nevertheless some car-builders, from the mere force of precedents, insist on having arm-rests made so high that they are uncomfortable. What is still more curious is that in some of the Wagner sleeping cars, in which the backs of the seats are not reversible, the arm-rests at both ends of the seats are made 11½ in. high. In both the Pullman and the Wagner cars the arm-rests at the outside ends of the seats are very uncomfortable. Not only are they too high, but they project inward and take up room lengthwise of the seat. On the Chicago, Burlington & Quincy Railroad we had the privilege of traveling in some cars equipped with ordinary seats and also others with reclining seats. These had the improved window recesses below the windows. Not only are the arm-rests at each end the right height for comfort, but they give room enough laterally for the arms of passengers occupying the seats. If a person sits close up against the side of a car his or her arm occupies from 3½ to 4½ in. of space. As the window recess referred to gives room enough for a person's arm, the practical effect is to lengthen the available sitting room in the seat from 3½ to 4½ in. In sleeping and other cars the window recesses not only have this advantage, but they provide receptacles for books, packages, etc.

The habit of smoking has now become so common that the popular mind has fallen into an attitude in which it is no longer conscious that non-smokers have rights which ought to be respected. Consequently we find that many modern sleeping-cars are provided with smoking apartments, to which perhaps no valid objection can be made if they are properly arranged. In the Wagner car, in which it was recently our lot to make a journey, the entrance to the smoking-room led almost directly into the main apartment of the car. Consequently the odor of more or less vile tobacco smoke at times pervaded the whole car. If the entrance to the smoking-room is toward the nearest end of the car, then, if that end is in front, the air is blown into the smoking-room and out the ventilators. If the smoking-room is at the rear end, the air which escapes from its door is drawn out of the back door of the car.

Another query many travelers must be disposed to make, Why are the wash-basins in sleeping cars made so low? When a car is running at considerable speed, especially on a crooked or rough road, it is almost impossible to preserve one's equilibrium while engaged in the morning ceremonial of washing one's face. When obliged to assume a position analogous to that of a partially opened three-bladed jack-knife, one cannot estimate the position of his center of gravity with the requisite celerity to retain his balance.

Although this report of an amateur inspector of sleeping-cars has exceeded its allowable limit of length, time and space will be taken for one more growl. The car in which it was his lot to travel from Chicago to New York was heated by steam from the engine. What the particular system of heating was is not known by the writer. It had one defect, however, which was serious. When steam was turned on the water-hammer was terrific. We use the latter word advisedly. The sound was as though a collision had occurred, and an engine or car had run into the one in which the hammering occurred. If the annoyance was remediable by the porter or conductor, they did not know how to apply or employ the remedy, which may perhaps be another reason for establishing some kind of civil-service examination for porters and conductors. Turning on steam in the car referred to would certainly make sleep impossible to all excepting the most confirmed and persistent snorers.

Our fault-finding has occupied so much of the space in this report that there is not room for more than a very little commendation. There are some things in which the last few years have brought great improvements in travel. Many of us can remember dismal hours spent in cars between nightfall and bedtime, when reading was impossible and the passing landscape was viewless, and the light inside the cars was insufficient to read by. The train which has been the subject of some animadversion was lit by the Pintsch gas system, and reading of good print was comfortable almost anywhere in the car.

Then, too, the leisurely feeding in a modern dining car is a great improvement over the meals hastily and nervously eaten at a wayside restaurant. The train service has generally improved, notwithstanding some defects which have been pointed out. The speed of trains has been increased and cars are generally more comfortable, so that one may now regard a journey as a period of rest and repose instead of one of weariness.

NEW PUBLICATIONS.

Water Tower, Pumping and Power Station Designs. *The Engineering Record's Prize Designs, Suggestive for Water Towers, Pumping and Power Stations.* (72 pp., 10¼ × 13½ in.) New York; *The Engineering Record.*

In 1890 the *Engineering Record* instituted an architectural competition and offered prizes amounting to $250 for the best designs for a water tower or pumping station. The purpose of the competition was to call out designs of a more or less artistic character, with a view to beautifying such buildings, which generally occupy prominent locations, and therefore may be either an offense or a pleasure to those who must look at them. One hundred and twelve designs were received, 56

of each structure. Prizes were awarded to four of these, and 13 received honorable mention. Engravings of these 17 selected designs are published in the volume before us.

The study of an architect's designs of purely engineering structures is always interesting, sometimes amusing, and at others infuriating. Many of them find it very difficult to act in accordance with Ruskin's maxim, to ornament their construction and not construct their ornament.

A criticism of the designs would, however, lead further than we are now prepared to go. Some of them indicate what many observant people have noticed before, that there are architects who adopt and pile useless ornament on their structures with apparently the same kind of wild and uncontrollable passion that some women manifest in their dress. Happily the consequences of this kind of lavishness is not so costly in the mere making of designs as it is in carrying them out. The plans of many of the water towers which are illustrated in the volume before us are very picturesque, and will at any rate be suggestive to those who have occasion to decide about building such structures.

The suggestions for pumping, power and electric-light stations will also aid those who have occasion to build such structures. The "treatment"—we believe that is the proper artistic term—of the chimneys in these designs is interesting. As such structures form very prominent objects, it would seem as though, if any parts of a building should be ornamented, it would be these but in the designs before us while a great deal of ornament is lavished on the buildings for the engines and boilers, there is very little on the chimneys or smoke-stacks. In the first design the chimney is an absolutely plain square structure, with a little taper toward the top. The second one is apparently plain, tapered and round, with a little moulding near the top, which is sketched in very indistinctly. The third is similar to the second. The fourth is also round, with a little moulding at the top, but with bands of differently colored stone or brick from its base all the way up. The sixth is square and plain, but with colored bands extending from a little above half its height to the top. The seventh is round and plain, with a flare at the top and very indefinitely drawn. The eighth is square at the base and octagonal above, with ornament on the corners of the octagon, and somewhat elaborate mouldings extending for some distance below the top. It is sketched merely in outline, but looks as though it might make a very simple and graceful structure. The ninth is square and perfectly plain, excepting a cap, which is slightly rounded inward or toward the center of the flue. The tenth is square, with plain mouldings near the base and more elaborate ones at the top. Between these points it is entirely plain. The eleventh is round and perfectly plain, with the exception of colored bands and a little moulding at the top. The twelfth is round and plain, with heavy ornamentation at the top. The thirteenth is square, perfectly plain, with the exception of a very slight projection around the top. The fourteenth is round and plain up to near the summit, where there are some heavy decorations. The fifteenth is square, with stones or bricks at the corners of different color from those between. The top has an ornament which reminds one of Downing's style of architecture, which overspread the country 30 or 40 years ago. The sixteenth does not show a chimney. The seventeenth shows a chimney with a square base and octagonal above, with somewhat heavy ornament near the top.

Nearly all the buildings connected with these chimneys are elaborately decorated. Now it is submitted that, in view of the prominence of the chimneys, that they have been neglected. What is wanted, Messrs. Architects, is new "treatment" and new "motives" for smoke-stacks. Ancient architecture gives us no examples of such structures, and the imaginations of our modern builders seem to have been singularly barren in suggestions. It is true that there is something prosaic about *chimneys*, which fact seems to have led our architectural friends to neglect them. It would not sound very fine to speak of a Renaissance chimney or a Gothic smoke-stack. Nevertheless, under the magic of modern science and civilization these structures have become veritable pillars of cloud by day and of fire by night.

One defect in nearly all the designs for pumping, power or electric-light stations is a lack of window room and light. Any building devoted to mechanical work or the shelter of machinery should have all the light in it possible. Even if little or no manual labor is carried on there, the care, supervision and inspection of machinery requires an abundance of light, and barring the glare of sunshine, there cannot be too much. Therefore all such buildings should have as little wall and as much window area as possible. More light is needed in a power house to run a steam-engine than is required in a church to say one's prayers.

The book before us is well printed, and the engravings, although made from rather sketchy drawings, serve their purpose very well.

Buildings and Structures of American Railroads. *A Reference Book for Railroad Managers, Superintendents, Master Mechanics, Engineers, Architects and Students.* By Walter G. Berg, C.E., Principal Assistant Engineer, Lehigh Valley Railroad. New York; John Wiley & Sons. Illustrated, 500 pages; price, $7.50.

One defect of modern engineering literature is its fragmentary and scattered nature, which is due to the large number of technical publications in existence, and also to the number of technical societies which are continually calling on the engineer for contributions to their proceedings. It results from this that a search for information on a given subject requires a hunt through files of all sorts, and sometimes valuable material is passed over or missed because it is not accessible to the searcher. The author who collects and edits information of this kind on a given subject and puts it in a form where it is ready for use does a service to the profession, even if his work does not extend beyond the compilation.

Mr. Berg, however, has done much more than this. He has collected and presented in excellent shape much that had already been published in this scattered way; but he has also added much original matter in the way of comment and criticism, and has also given many designs for buildings on different railroads which have not heretofore been published. He has evidently done some careful work, and has taken pains to bring his accounts up to the latest date; a matter of considerable difficulty in an age of constant change.

The subjects treated include buildings of every class: Stations—including a number of important terminal stations—shops, section houses, water stations, coaling platforms and a number of others, including some which are very useful after their kind, but do not often find mention, such as sand-drying and storing houses, oil-mixing houses and others. The variety of structures needed on a railroad can hardly be appreciated by those who have not had experience in building or using them; but some idea can be obtained from this book.

The text is generally well written, not at all diffuse but rather condensed, and many of the criticisms are pointed and well taken. It is very fully illustrated, nearly 700 drawings and diagrams being given in the work.

BOOKS RECEIVED.

A Treatise on Gear Wheels. Sixth edition. By George B. Grant. Lexington, Mass.; published by the Author.

Tenth Annual Report of the Board of Railroad Commissioners of Kansas for the Year ending December 1, 1892. Topeka, 1892.

Twenty-fourth Annual Report of the Board of Railroad Commissioners of the Commonwealth of Massachusetts: January, 1893. Boston, 1893.

Annual Report of the State Board of Arbitration of the Commonwealth of Massachusetts for the Year 1892. Boston, 1893.

Journal of the United States Artillery: January, 1893. Fort Monroe, Va.; published by authority of the Staff of the Artillery School.

Journal of the Military Service Institution: March, 1893. Governor's Island, New York Harbor.

Journal of the American Society of Naval Engineers: February, 1893. Washington, D. C.

Professional Papers of the Corps of Royal Engineers. Edited by Captain W. A. Gale, N.E. Chatham.

Infantry Drill Regulations, United States Army. With interpretations of 250 Pars., by the Recorder of the Tactical Board. New York; *Army and Navy Journal.*

TRADE CATALOGUES.

THE DEITZ DRAWBAR COMPANIES, Denver, Col. (8 pp., $3\frac{1}{4} \times 6$ in.)

This little publication illustrates and describes two forms of couplers, one of the link and pin type and the other of the M. C. B. type. Two companies have apparently been organized for the manufacture of the two types of couplers, which are illustrated and described in the catalogue before us.

HEISLER'S GEARED LOCOMOTIVES. *Charles L. Heisler, M.E.* Philadelphia.

In this diminutive pamphlet (12 pp., $3\frac{1}{4} \times 6$ in.) the author describes a system of locomotives of which he is the inventor. The chief peculiarities are that the locomotives are supported on two or three trucks which are driven by gearing and longitudinal shafts. The construction could not, however, be explained so as to be understood without the aid of engravings.

MODERN ELECTRIC, STEAM AND HAND CRANES, *for Foundries and Machine Shops, Iron and Steel Works, Electric Power Stations, etc.* Built by Pawling & Harnischfeger, Milwaukee, Wis. (8 pp., $6 \times 9\frac{1}{2}$ in.)

In this publication a swing and several forms of travelling cranes are illustrated and described. These may be driven by hand, electric, or steam power. The engravings and descriptions are clear and satisfactory to the reader. The catalogue is an indication of the extent to which this class of machinery has of late years been introduced into this country.

The above firm also make lathes, drilling and boring tools, and special machinery.

CONSOLIDATED CAR-HEATING COMPANY. *Part IX. Improved Locomotive and Tender Equipment*, Albany, N. Y. (12 pp., $7 \times 10\frac{1}{2}$ in.)

This is one of a series of parts of a catalogue issued by this Company to describe their steam-heating apparatus. Part IX. contains first two large folded plates, showing the positions in which the Sewall steam couplers should be located on cars and locomotives. These are followed by a description of the locomotive equipment for steam heating, and also of the method of heating fruit, freight, and baggage cars.

THE MCSHERRY MANUFACTURING COMPANY, *Manufacturers of the Maxon Patent Lever, Screw and Ratchet Lifting Jacks*, Dayton, O. (30 pp., $6 \times 8\frac{1}{2}$ in.)

Not much can be said of this catalogue, excepting that it illustrates very clearly the different kinds of railroad and wagon lever and screw jacks made by the Company. The engravings are very good and the descriptions clear. One feature of the arrangement is very good. A full page is devoted to the engravings of most of the jacks, and on the opposite page illustrations are given of the different parts or "repairs" of the implement shown which are all suitably numbered. Neither the paper nor the printing is of a "fancy" character, and the impression produced by the catalogue is that there is no nonsense about it or about the implements it describes.

ALMY WATER-TUBE BOILER COMPANY, *Manufacturers of Almy's Patent Sectional Water Tube Boiler for Marine and Stationary Work*, Providence, R. I. (Third edition, 16 pp., $5\frac{3}{4} \times 8$ in.)

The title-page of this pamphlet gives a perspective external view of one of the boilers, which is followed on the next page by an introduction. This is succeeded by a description of the construction of the boiler. After this are various outside and sectional views. The description, it is thought, would have been a great deal clearer if it had referred directly by letters of reference to some of the sectional views, as an explanation is always much easier understood if accompanied with an object lesson in the form of a picture.

Engravings and tables of dimensions of different sizes of boilers are given, and after them a statement of the advantages claimed, and the volume ends with a comparative statement of the performance of one of these boilers on the steamer *Queen City*, and a list of the boilers furnished to different parties.

DESCRIPTIVE CATALOGUE OF THE FOSTER STEAM-PRESSURE REGULATORS, PUMP GOVERNORS, AND REDUCING-VALVES; *also of the McDowell Inside Safety Check-Valve for Locomotive and Marine Boilers.* Foster Engineering Company, 21 and 23 Prospect Street, Newark, N. J. (32 pp., $6 \times 9\frac{1}{4}$ in.)

This is a well-printed and well-illustrated publication of its class. The frontispiece is a "half-tone" engraving showing the interior of the assembling and testing-room of the Company. Another similar engraving farther on in the pamphlet shows the testing apparatus. The publication opens with a statement of what the Company makes, which includes the Foster pressure regulator, a combined steam-pressure regulator and pump governor, a regulator operated by a piston and lever, a valve for regulating the steam heating of trains, another for steamships, an "all round" valve for melting and manufacturing plants, and the McDowell inside safety check-valve for locomotive and marine boilers. All of these are well described by excellent wood-engravings and well-written explanations of their construction and operation. These are succeeded by directions for setting and operating the valves and "testimonials" of their efficiency. It is an excellent example of this kind of literature, although we are inclined to think that if the commendation in it of the articles made by this Company was a little less vehement it would be more convincing, but probably the author thought, as many people do, that "he that bloweth not his own horn, verily it will not be blown."

THE LINK BELT MACHINERY COMPANY, of Chicago, Ill., have sent us half a dozen publications illustrating different kinds of machinery which they manufacture. The one on

special mining machinery (4 pp., 6 × 8 in.) announces that they have associated with them Mr. Howard McLean as Superintendent and Mr. Thomas R. Griffith as Engineer of Construction, and that they are prepared to supply special mining machinery, which is intelligently designed and thoroughly well made, including breaker rolls, coal screens, mine ventilating fans, and tail and endless rope haulage.

Another of the publications (16 pp., 6 × 8½ in.) is on MANILLA ROPE POWER TRANSMISSION as applied by this Company. Its frontispiece is a very good wood-engraving showing a view of their works, and the beginning is on rope driving and its advantages. On the fifth page is a half-tone illustration showing the driving-gear in the dynamo-room of the Virginia Hotel in Chicago. The following page has a similar illustration of the dynamo drives in the Chamber of Commerce Building in Chicago. The following seven pages contain engravings made from pen-and-ink drawings, which, as works of art, cannot be commended very highly, but they nevertheless answer their purpose of showing the construction and arrangement of various factory "drives" or "rope transmissions" which the Company have put up in various localities. These engravings also have very terse and clear-printed descriptions appended. Two pages of testimonials and two more of general advertisements conclude the pamphlet.

The third of the series is a four-page folder giving an engraving and description of a system of conveyers for handling corn and husks. It is added that they have supplied similar machinery for elevating and conveying cobs, pea-pods, tomato slops, green vegetables, fruits, fish, meats, cans, boxes, etc.

The fourth publication of the series is an eight-page folder describing and illustrating elevating and conveying machinery, and gives very good engravings and descriptions of elevators for handling barrels, baled hay, boxes, ashes, and other materials.

The fifth of the series is a single leaf giving an engraving of a brick-dust elevator.

The sixth illustrates and describes a locomotive coaling station erected at New Buffalo, Mich., on the Chicago & West Michigan Railroad.

The last publication is a pamphlet of 24 pages, 5½ × 8 in., and describes special machinery for use in saw-mills, planing-mills, and wood-working establishments. All of these circulars are well printed on coated paper, and the engravings, with the exception noted, are of the best. In these days of standards one wonders though that this Company did not make all their catalogues of uniform size. Some of them would have gained in clearness, too, if fancy-colored ink had been ignored and good black ink only had been used.

NOTES AND NEWS.

Advertisements Prohibited.—The following order emanated from the Maine Central Headquarters last week, addressed to all station agents and section foremen along the line: "You will not allow any parties to paint signs or place posters or advertisements on walls or fences belonging to this company; nor on any objects upon land belonging to this company or within our right of way. It is the intention of this company to have its station grounds and right of way present a neat and attractive appearance, and your co-operation in securing this is desired and expected."—*Portland (Me.) Argus.*

A remarkable artesian well-boring has just been completed at Willoughby, in Lincolnshire. Owing to an inadequate water-supply for the locomotives running on the Sutton & Willoughby Railway, the company decided to bore. At a depth of 245 ft. from the surface the workmen struck upon a bed of iron-stone, which took them a considerable time to penetrate, but beneath this rock a magnificent spring was met with. For some time the water threw out tons of blue sand, but it eventually cleared, and it now flows over a 2½ in. tube 30 ft. above the ground, at the rate of 4,619 galls. per hour, or 1¼ galls. per second. The spring is said to be the strongest yet obtained in Lincolnshire.—*Engineer.*

The Efficiency of Boilers.—In a recent discussion by the Engineers' Club, of Philadelphia, U. S. A., on this subject, Mr. Strong stated that the difficulty in the way of introducing producer plants and gas engines is the first cost and difficulty of starting the engines; but the latter difficulty will probably soon be overcome, and the gas-engine will then supersede the steam-engine in many cases. An engine has been designed which is to make a horse power on 13 lbs. of water, to carry 180 lbs. pressure in the boiler, allowing the gas to escape at 250°, and evaporating 12 lbs. of water to a pound of coal. Many think that the locomotive is an uneconomical steam-engine, but it really compares very favorably with the general run of automatic engines to be found. A few years ago a test was made on the Lehigh Valley Railroad, under favorable circumstances, on a boiler having 1,848 sq. ft. of heating surface; 900 H. P. was developed, 8 lbs. of water being obtained per pound of coal; and in another boiler which was tested, 28 lbs. of water to the H. P. was used, while in the one first spoken of only 20 lbs. was used. The Boston sewage pumping plant is getting about 12 lbs. of water per pound of coal, using two sets of boilers. In the locomotive we get 9 lbs. of water while we were making 2 H. P. for each 2 sq. ft. of grate. As opposed to this, Mr. Spangler said that he doubted very much whether the boiler had been made which would average 12 lbs. of water per pound of coal.

The Largest Express Engine in the World.—A few years ago one of the Webb three-cylinder compound locomotives was sent over from this country to America for trial; however, the results of practical and perfectly fair tests is that the English engine has been very badly beaten. This fact appears to have induced Mr. F. C. Winby to design an English engine to send to the Chicago Exhibition, and it is just completed at the works of Messrs. R. & W. Hawthorn, of Newcastle, and within the past few days a very large number of engineers have accepted the invitation to inspect the new engine. This vast locomotive, named the *James Toleman*, runs upon a four-wheeled leading bogie, and two pairs of independent driving-wheels of 7 ft. 6 in. diameter, and it has four high-pressure cylinders. Two cylinders placed inside under the smoke-box are 17 × 22; they actuate the first pair of driving-wheels. Two outside cylinders are placed behind the bogie wheels; they are 16½ × 24, and work the second or trailing pair of driving-wheels. The total tractive force exerted by the four cylinders upon the four driving-wheels is therefore 143 lbs. for each pound of effective pressure. The boiler works at a pressure of 175 lbs., but it is constructed to carry 200 lbs., if necessary. The boiler is of oval section, in order that it may be placed between the tops of the driving-wheels. Number of tubes, 189; diameter of tubes, 2⅝ in.; length of tubes, 16 ft.; heating surface of tubes, 1,880 sq. ft.; heating surface of fire-box, 138 sq. ft.; total heating surface, 2,018 sq. ft.; area of fire-grate, 28 sq. ft.; weight of engine in working order, 60 tons; and the tender, when loaded, is fully 45 tons, so that the engine and tender complete weigh about 105 tons. Mr. Winby has therefore designed, and Messrs. Hawthorn have constructed, the largest locomotive ever seen in England; and the fact that the engine uses high-pressure steam in all the cylinders is a most important feature in its favor. Its construction has been watched both in this country and in America with very great interest.—*Communicated to the Leicester (England) Daily Mercury.*

FOREIGN MARINE NOTES.

Viking Ship.—The Viking ship, intended for the Chicago World's Fair, was recently launched in Christiania, Norway, amid great enthusiasm.

The old Viking ship of Gogstod was discovered about twelve years ago near the village of Sandefjord, where it had lain buried for a thousand years or more.

The vessel launched is a true copy of the original. It will be manned by Norwegian sailors and sailed across to Chicago.

A Curious Transformation of Brass.—A curious incident has been noticed in connection with the brass condenser tubes of a foreign cruiser. The pipes, after being in use for rather more than twelve months, were found to have experienced a peculiar change. In many places the metal has been, it appears, converted into almost pure copper of a spongy texture, the zinc of the alloy having completely disappeared. An investigation which was made showed the probable cause of the failure to have been an electrolytic action between the tin lining of the tubes and the brass, the sea-water circulating through the condenser forming the electrolyte. Had the tin coating remained perfect, doubtless no corrosion would have

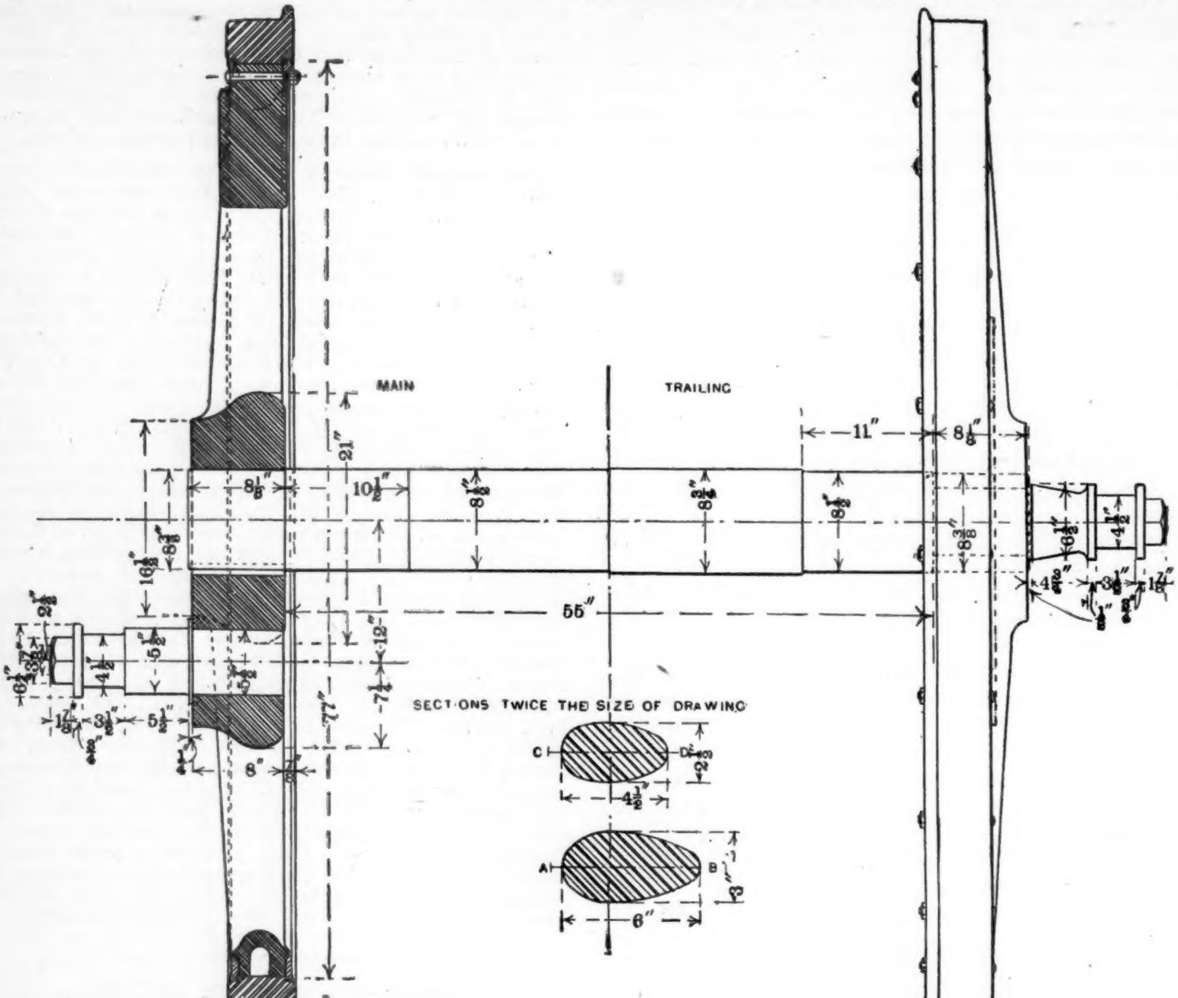
resulted, but the mud and grit conveyed in suspension through the condenser carried away the tin coating in spots, and it was at these points that the transformation of the metal occurred. It is concluded that if the pipes had not been tinned at all, they would have remained intact.—*Iron.*

Foreign Whalebacks for American Trade.—The American Steel Barge Company has contracted to build two vessels at or quite near Liverpool, Eng., on the general plan of Captain Alexander McDougall's whalebacks. One will be a steamer and the other a tow barge or consort, and as such they will be the first vessels of the kind to cross the Atlantic Ocean. They will be put into the iron ore trade between Cuba and Philadelphia, and will be ready for their first cargoes in July. They will be duplicates of the *James B. Colgate*, only 2 ft. deeper and with more power, the engines being the same style and size as those in the big *Pathfinder* launched last year.

The vessels will sail under the British flag and will carry short pole spars similar to those employed on the *J. L. Colby*. These vessels will be the forerunners of an extensive fleet to be built abroad at various seaports before the close of 1894. The combined carrying capacity of the two vessels will be 9,000 tons.

The "Cambrian."—On Monday, January 30, there was launched at Pembroke Dockyard Her Majesty's ship *Cambrian*. The displacement of the *Cambrian* when fully equipped and ready for sea will be 4,360 tons. She is 320 ft. long, her extreme breadth is 49 ft. 6 in., and her depth of hold 15 ft. 6 in. When completed and ready for commission, with ammunitions, stores and all equipments on board, her mean draft will be 19 ft. Her upper deck will be 14 ft. 3 in., and the center of her midship guns 18 ft. above the water-line. The hull of the vessel, which is built of ¾-in. steel plates, is sheathed with wood 3½ in. thick, to the height of about 1 ft. above the water-line. A protective deck of varying thickness extends throughout the whole length of the ship. Her circular conning tower, situated on the forecastle, is formed of 3-in. steel armor plates, the top or covering plate being 1 in. in thickness; her torpedo-director tower, situated near the stern, is wholly built of ½-in. steel plates. Like her sister vessels, she is to be fitted with twin vertical triple-expansion engines, the diameters of the cylinders being, high-pressure, 49 in.; low-pressure, 74 in. The engines are to make 140 revolutions a minute, and to develop, under forced draft, during a continuous sea trial of four hours, 9,000 H. P., and with ordinary draft 7,000 H. P. The estimated cost of the hull is $70,000, and of the engines and auxiliary machinery, $250,000.

Steam Hammer on Board Ship.—Considering the exceptionally solid foundations that are required for steam hammers, this class of tool would seem to be altogether out of place on shipboard; but Messrs. B. & S. Massey, of Openshaw, have recently supplied to H. M. Dockyard, Devonport, one of their steam-hammers, which is to be fixed on board H. M. S. *Defense*, which has been converted into a floating factory. To meet the requirements of the peculiar position in which the hammer is to be placed, special construction has, of course, been necessary. The hammer is of the overhanging form, with two standards, in which are planed guides, and between these the tup has a falling weight of 3 cwt.—without taking into consideration the pressure of the top steam—and the maximum stroke is 17 in., the diameter of the cylinder being 7½ in. The hammer is fitted with combined self-acting and hand-worked valve-gear, and will work very quickly or slowly, as desired, the change either as to speed or force of blow being effected instantly. In the special arrangement of the hammer, the separate anvil-block and base are made in one massive casting of great weight, so as to cause as little vibration as



DRIVING WHEELS AND AXLE OF AMERICAN EXPRESS PASSENGER LOCOMOTIVE.

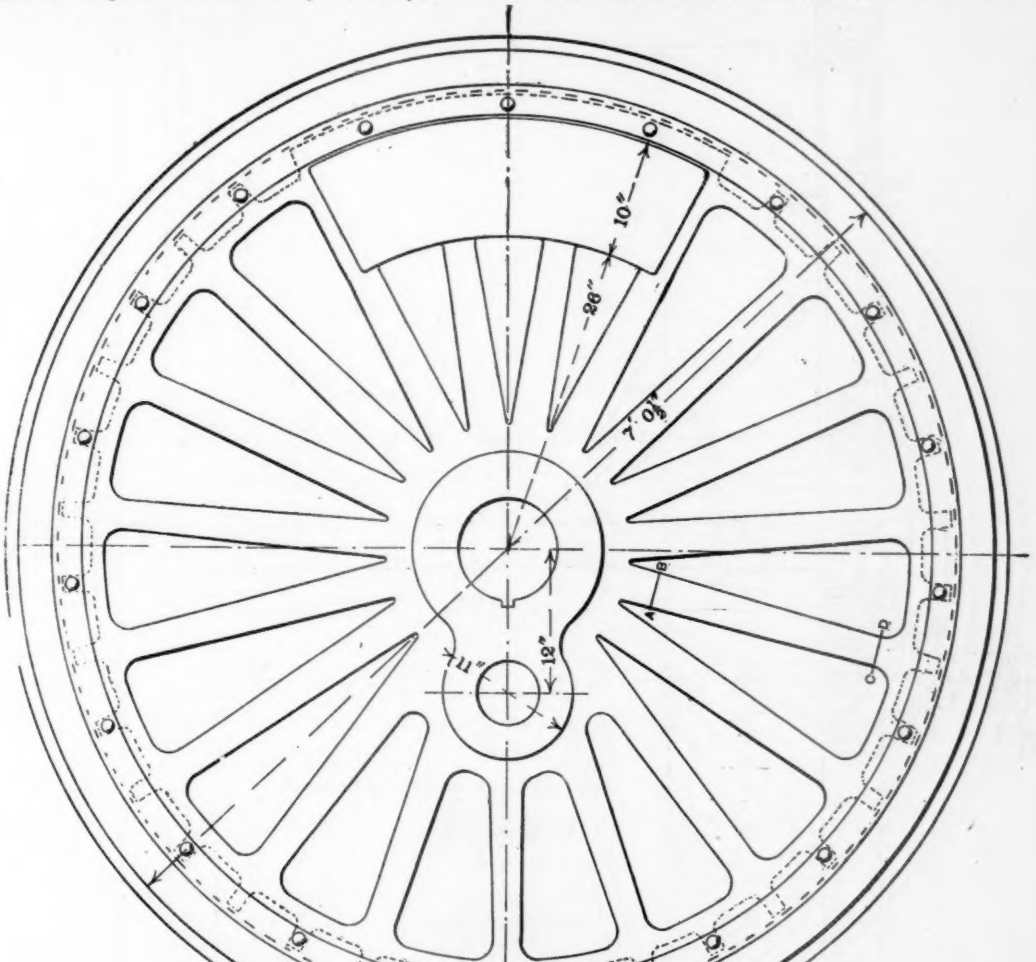
possible in the surrounding parts of the ship, and a 6-in. armor plate is fixed underneath in a vertical position, as a foundation for the anvil-block. This is perhaps the first time that it has ever been attempted to erect a steam hammer except on land, and no doubt the one supplied by Messrs. Massey will prove a very useful tool for repairs on board the floating factory at Devonport.—*English Mechanic.*

The "De Julio"—The Argentine Navy enjoys the distinction of possessing the fastest cruiser in the world. This vessel has recently been built in the English shipyard of Sir W. G. Armstrong, Mitchell & Company, and the steam trials conclusively show that she possesses a speed which under natural drafts has only been equalled by the fastest of the Atlantic liners in the most favorable conditions of wind and sea. She is known as the 9 *De Julio*, and is 350 ft. long, 44 ft. broad, and has a displacement of 3,500 tons.

The propelling machinery consists of two sets of four-cylinder triple-expansion engines, the two low-pressure cylinders in each set having a diameter of 66 in., the intermediate cylinder 60 in., and the high pressure cylinder a diameter of 40 in., the length of the stroke being 30 in. Steam is generated in eight single-ended return tube boilers, situated in two separate water-tight compartments, each compartment containing four boilers. Each set of engines is also confined in a water-tight compartment. In a series of runs the speeds ranged from 11¾ knots up to 22.74 knots, the latter mean speed being obtained under forced draft. The six hours' run was made under natural drafts, in accordance with the conditions laid down by the British Admiralty. During this period of steaming four runs were taken on the measured mile, and the speeds and revolutions were accurately taken by stop watches and the mechanical counters in the engine-rooms. The speeds and revolutions were also recorded by an electric apparatus in the chart-house of the ship, which noted on a traveling band of paper each revolution of each engine, each half second of time, and the beginning and ending of each run for the mile. The mean speed of these four runs was 22.028 knots, corresponding to the mean revolutions of engines of 149.1 per minute. The average revolutions of the engines during the six hours' run were 148.3 per minute. The vessel is armed entirely with quick-firing guns of the latest and most approved pattern. She carries four 6-in., eight 4.7-in., twelve 3-in., and twelve 1-in. quick-firing guns. She also carries five 18 in. torpedo-tubes.

AMERICAN AND ENGLISH LOCOMOTIVES.

On pages 164 to 169 we give this month engravings of the driving-wheels, axles, crank-pins, and driving-axle boxes of Mr. Buchanan's express passenger locomotive on the New York Central Railroad, and the same parts of Mr. Adams's engine for the London & South Western road.



DRIVING WHEEL OF AMERICAN EXPRESS PASSENGER LOCOMOTIVE.

The following are the specifications of these parts for the American engine :

DRIVING-WHEELS.

Four in number. About 84 in. diameter. Centers cast of the best charcoal iron and turned to 77 in. diameter to receive the tires.

TIRES.

Of steel 3¾ in. thick ; both pairs flanged 5¾ in. wide, and held to center by retaining rings.

AXLES.

Of hammered iron, with journals 8½ in. diameter by 11½ in. long.

DRIVING-AXLE BOXES.

Of Ajax metal with large oil-cellars.

SPRINGS.

Made of the best cast steel tempered in oil. Secured to a system of equalizing beams to insure the engine riding in the best possible manner. The springs to be hung underneath the driving-axle boxes.

CRANK-PINS.

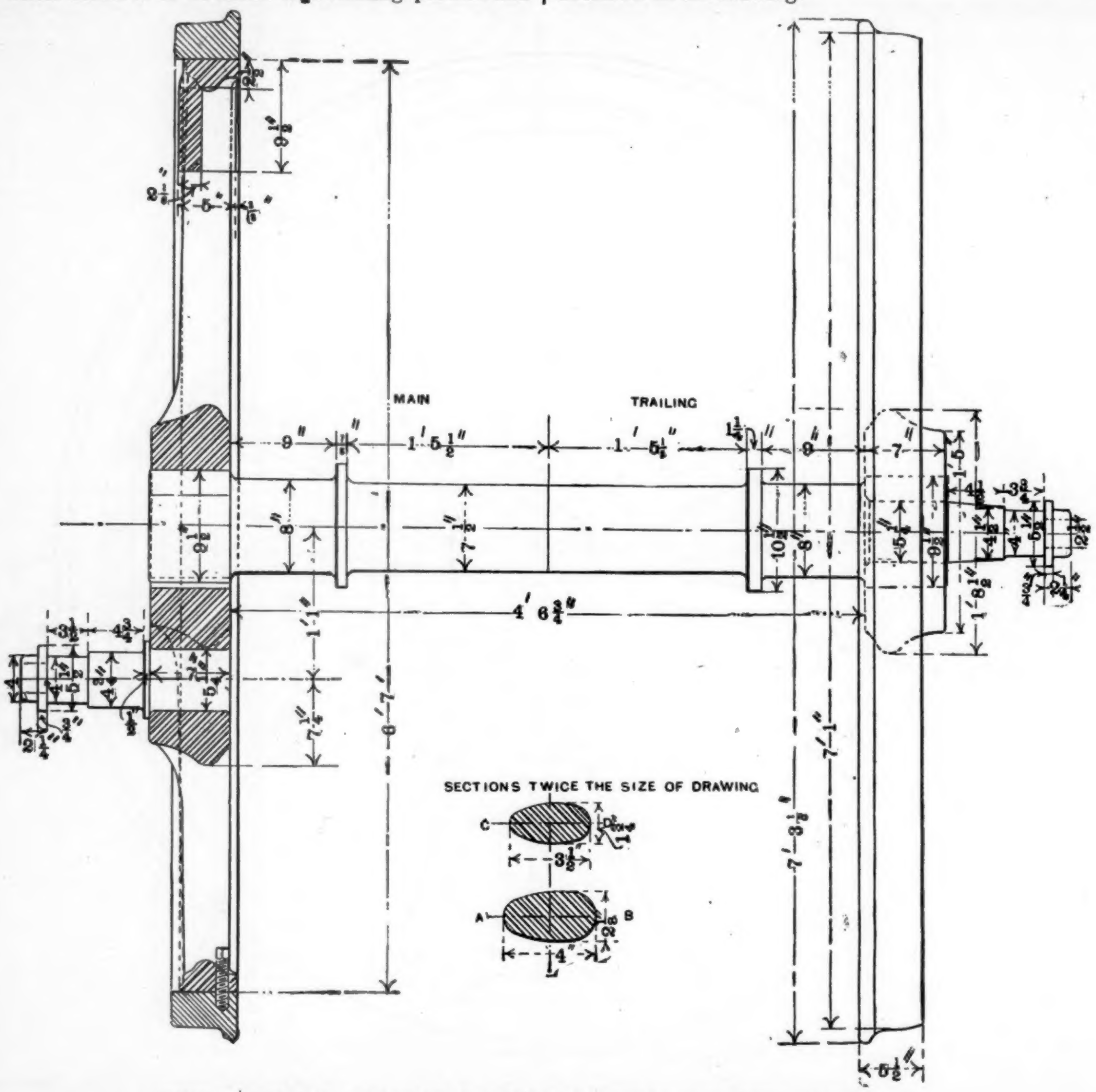
Of hammered iron.

Specification of English Express Locomotive.

DRIVING AND TRAILING-WHEEL CENTERS.

The wheel centers to be of good sound cast steel, of approved make, free from honeycomb and other defects. One wheel center out of 40 is to be tested to destruction under the following conditions:

The wheel center is to be raised in a running position and alike, and each wheel must be forced on the axle before the tire is shrunk on by a hydraulic pressure of not less than 80 tons. The rims must be correctly turned to gauge to receive the tires, and the whole wheel trimmed up so that the surfaces and lines are all fair and true. The wheel centers are to be turned to a diameter of 6 ft. 7 in., the rims are to be 4⅛ in. broad, 2¾ in. thick at center, to have 22 spokes, 2¼ in. thick at the boss, and 4 in. deep, and at the rims 1¾ in. thick by 3½ in. deep. The bosses are to be bored out parallel to a diameter of 9½ in., and are to be 1 ft. 5 in. diameter. The cranks for the coupling-rods are to be cast solid with the bosses, 13 in. centers, and bored out parallel to a diameter of 5¼ in. to fit the coupling-rod crank-pins. The crank-pin holes are to be bored in a suitable quartering machine. The balance weights to be cast solid and to be different for the driving and trailing-wheels. Care to be taken that each wheel is cast with its proper balance weight. Generally the wheel centers must be as shown on the drawing.



DRIVING WHEELS AND AXLE OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

allowed to fall upon a solid foundation from the following heights: 10 ft., 15 ft., 20 ft., 25 ft., 30 ft.

Should any wheel center break at the two lower heights—viz., 10 ft. or 15 ft., and show defects on hard material, the Railway Company's Locomotive Superintendent or his Inspector shall have the power to reject the whole. The wheels to be inspected on the premises of the maker.

Tensile test pieces are to be taken from the wheel center to give a breaking strain of not less than 28 tons per square inch, with an elongation of not less than 20 per cent. in 2 in.

Each wheel center is also to be tested, by being allowed to fall in a running position a distance of 4 ft. 6 in. on to a wooden block, without showing any signs of defect.

All the wheel centers must be bored, and turned, and have keyways cut strictly to template so that they shall be exactly

TIRES.

The tires are to be of the best cast steel, manufactured by Vickers & Company, and are to be tested at the works of the maker in the following way:

Each tire is to be guaranteed to stand, without fracture, the repeated falling of a 1 ton monkey from a clear height, first blow, 10 ft.; second, 15 ft.; third, 20 ft.; fourth, 25 ft.; fifth, 30 ft., and so on. Any tire which cracks or breaks before it has deflected one-sixth of its external diameter is to be rejected.

Test pieces are to be machined cold out of the tire, without reheating the steel or treating in any way beyond cold machining, for tensile test. The minimum tensile strength to be 44 tons per square inch, and to have an extension of not less

than 15 per cent. in 2 in. A suitable and sufficiently large piece is to be sent to Nine Elms for testing in a similar manner.

The contractor shall require the maker to provide at his own expense one additional tire for each 50 ordered, to be selected from the bulk by this Company's Locomotive Superintendent or his Inspector, and to be tested in his presence by the maker in the manner before described.

In the event of one tire cracking or breaking, or failing to stand the test, the Company to have the power to reject the whole.

The number of the charge is to be stamped on each tire, and in the event of there being more than one charge in every 50 tires, a tire shall be selected from each charge and tested.

The maker's name and date of manufacture is to be stamped on each tire.

All the tires are to be 3 in. thick, of the form shown on drawing, and to be secured to the wheels with a lip and steel set screws 1¼ in. diameter, 11 threads per inch. Each tire to be bored to gauge before being shrunk on the wheel center. Each tire to be accurately turned so that the diameters and thickness shall be exactly similar.

AXLES.

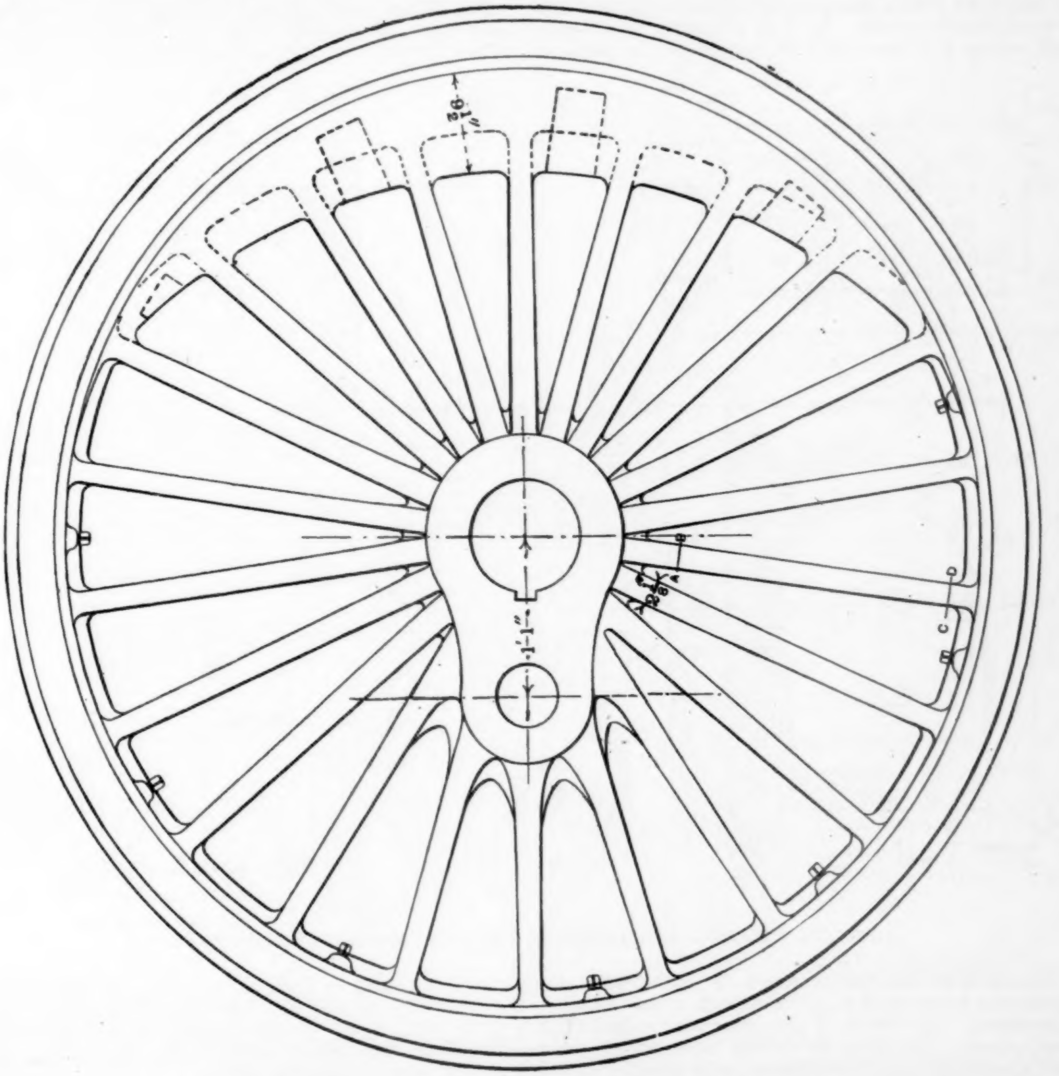
All the axles must be of the very best cast steel, manufactured by Vickers & Company, and must be stamped with the maker's name and date of manufacture. Test pieces are to be made giving a tensile strength of not less than 28 tons, and not more than 32 tons per square inch, with an elongation of not less than 25 per cent. in 2 in.; a piece of suitable length, 1¼ in. square, is to be bent double when cold without showing any signs of failure. The bogie axles to have centers of bearings 3 ft. 7 in., 5¾ in. diameter, 10 in. long. The driving and trailing axles to have centers of bearings 3 ft. 9¾ in., 8 in. diameter, 9 in. long. All axles to be as shown on drawings.

DRIVING AND TRAILING AXLE-BOXES.

The driving and trailing axle-boxes to be as shown on drawin : of the best gun metal, and to have bearing surfaces of Dewrance's anti-friction metal ; keeps to be of cast iron. The axle-boxes to have lubricating pads as shown. There is to be only one groove in the crown of the axle-boxes, with the lubricating holes leading into it. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle journal, to give clearance. The axle-boxes must have $\frac{1}{32}$ in. side play on each of the guides. Each axle-box must be made to gauges and must be duplicates of each other.

DRIVING AND TRAILING SPRINGS.

The springs are to be made of the very best quality of spring steel, manufactured from Swedish bar iron. Five per cent. of the bars to be tested at the works of the makers by the Railway Company's Locomotive Superintendent or his Inspector, in the following manner: A piece to be cut from each bar, 2 ft. 6 in. long, heated and bent round to a radius equal to 80 times the thickness of the bar, then hardened and tempered. The camber to be taken after it has been pushed straight once in the testing machine, after which the bar must be pushed straight six times without showing any further permanent set. The tensile strength of the bars to be not less than 45 tons per square inch, with an elongation of not less than 15 per cent. in 2 in. Manufacture and brand to be approved by the Railway Company's Locomotive Superintendent. The plates are to be truly fitted, tempered, and stamped



DRIVING WHEEL OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

with the maker's name and date of manufacture. The plates to be prevented from shifting side or endways by nibs stamped upon them. Care must be taken that the nibs formed on the plates fit the slots properly. The buckles are to be sound forgings and are to fit the springs accurately, and are to be well secured to them, the buckles to be prevented from shifting on the springs by short wrought-iron pins, driven while hot, through holes in the top and bottom of the buckle, and into a hole in the top plate and a recess in the bottom plate, as shown on the drawing. The springs are to consist of 12 plates ½ in. thick and 5 in. broad, to a span of 4 ft., and to have adjustable hangers at the end and solid hangers in the center. Each spring must be thoroughly tested before being put in its place by being weighted with 11 tons, and on the removal of this weight the spring must resume its original form.

SPRING GEAR.

A compensating beam to be attached to the driving and trailing springs, of wrought iron, forged as shown on the drawing, and fitted with a phosphor-bronze bush, pressed into its place by hydraulic power. It is to be carried by a forged cross-shaft, which is to be carried by two forged brackets, as shown. The ends of the springs which do not engage with the compensating beam must be provided with suitable forged hangers, as shown. The whole of the spring gear to be forged in a sound manner, free from all defects whatsoever. The spring and compensating beam brackets to be attached to the frame by ⅞-in. turned cold rivets of best Yorkshire iron, having a tensile breaking strength of not less than 22 tons per square inch, with an extension of not less than 30 per cent. in 2 in.

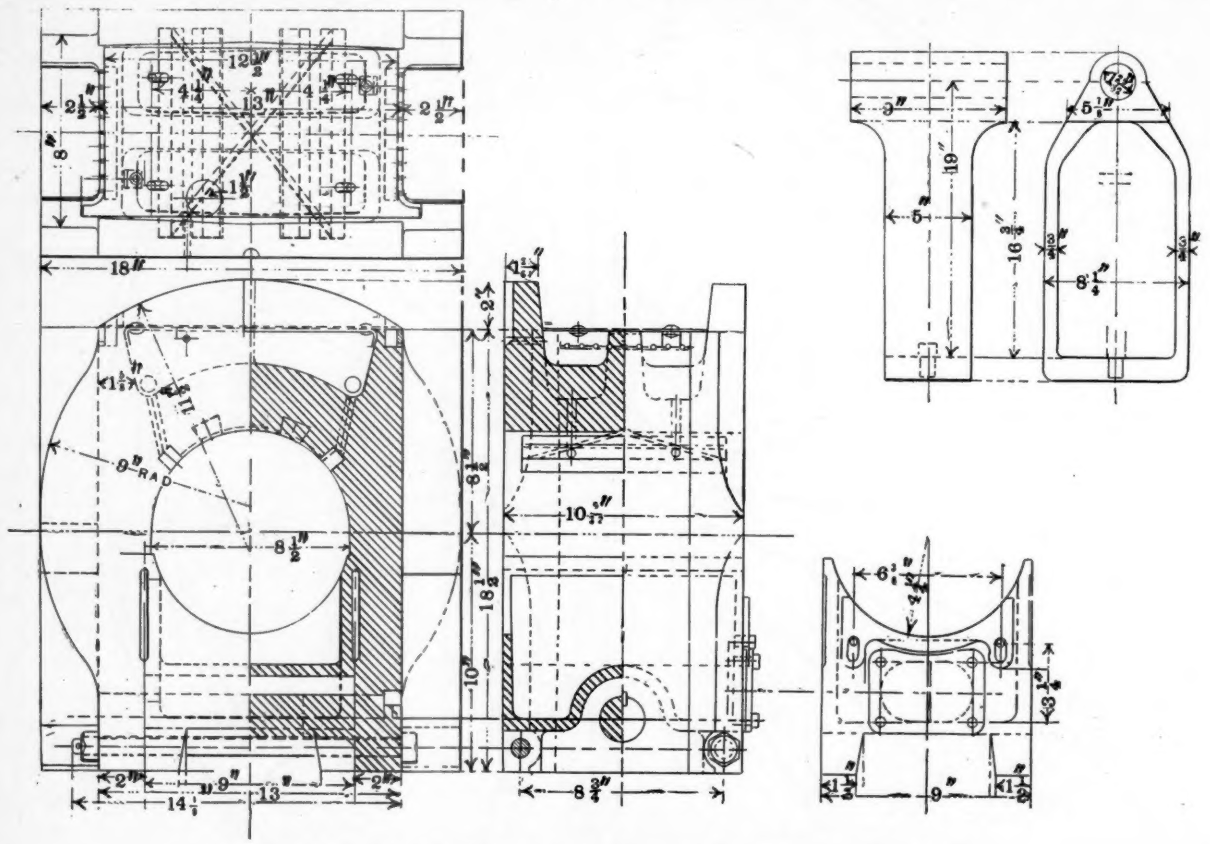
CRANK-PINS.

The crank-pins are to be of the best Yorkshire iron properly case-hardened on the wearing surface. The hole in the wheel is to be parallel as shown; the pins are to be accurately fitted and pressed into the wheels before the tire is shrunk on by hydraulic power of not less than 30 tons, and riveted over on the inside. Cottered washers are to be placed on the ends as shown on detail drawing.

The chief differences in the construction of the parts of the American and English locomotives illustrated this month is in the materials used for the driving-wheel centers—those for the American engine being made of cast iron, and the English centers are made of cast steel. It would be interesting if the weights of these parts could be compared, but unfortunately we are not able to give the weight of either. The tires of Mr. Buchanan's wheels, it will be seen, are secured to the wheel centers by Mansel retaining rings. It must be admitted, though, that this practice is seldom followed in this country, and our locomotive tires usually have no other fastening to the wheel centers, excepting the shrinkage of the tire, unless a shoulder is turned inside the tire to bear against the rim of the wheel. Mr. Adams's tires, it will be noticed, are fastened with set screws which are let into holes drilled into the tire, a practice which has been rather severely criticised both in England and this country.

A noticeable feature is that the English axles are made of cast steel, whereas the American are wrought iron. Another is that the English axles are made larger in the wheel-seat than they are in the journals, a practice which is generally followed in English locomotives, and probably adds to the strength of the axle inside of the hub, the point where breakage occurs most frequently. The English axle also has solid collars inside of the journal. When collars are used here they are usually loose and fastened with set screws. They have the advantage that when they become worn they can be replaced or reset on the axle. It will be noticed tha the journals of the American engine are 8½ in. diameter by 11 in. long; those for the English engine are only 8 × 9 in. The larger journals are required for the former, owing to the greater weight carried on them.

In the construction of the crank-pins there is no material difference, excepting that the bearings are larger in the American than in the English machines.



DRIVING AXLE-BOX FOR AMERICAN EXPRESS PASSENGER LOCOMOTIVE.

HOME MARINE NOTES.

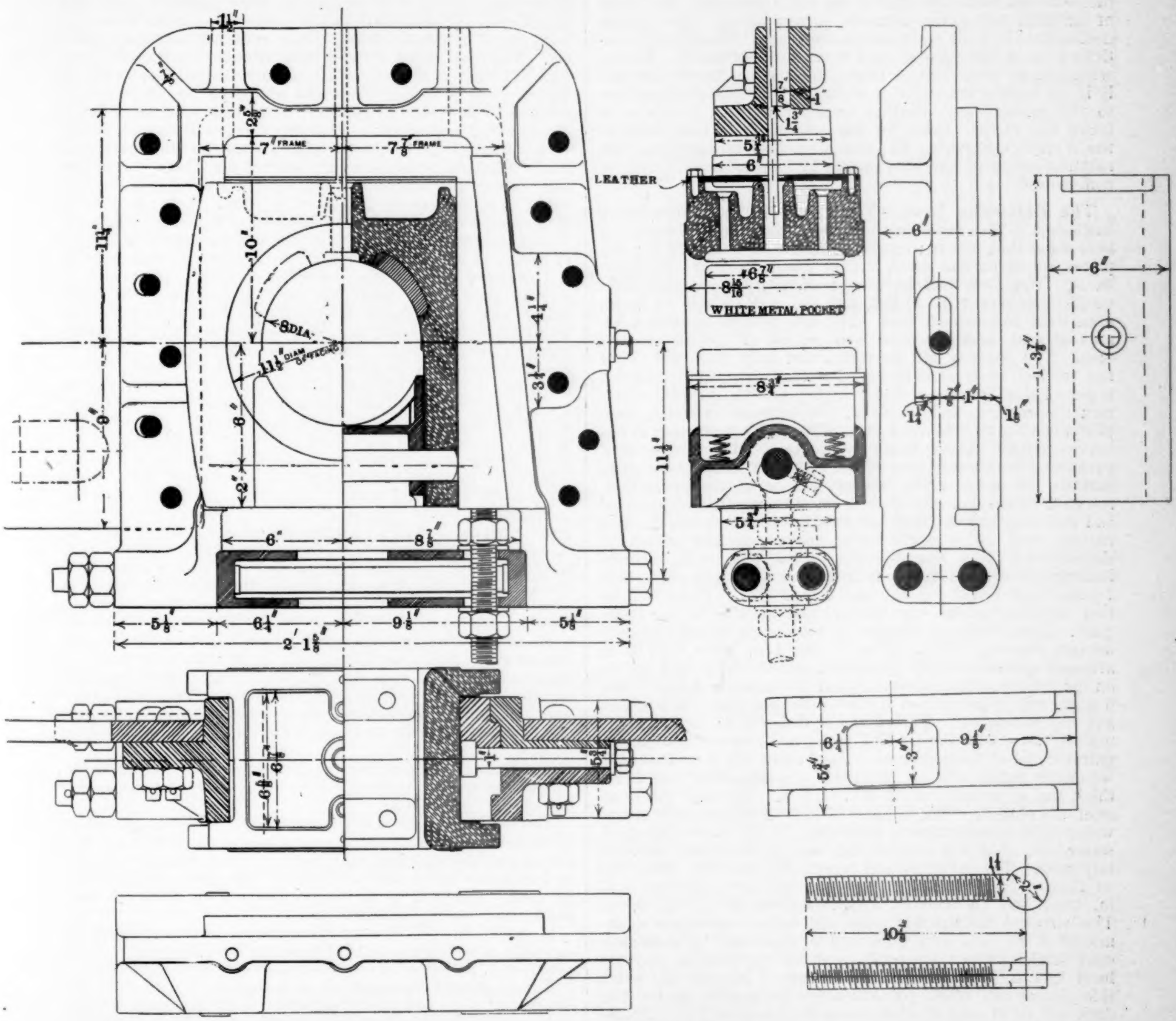
New Steamers for the Lakes.—A steel steamer is to be built at Wyandotte for the Detroit Dry Dock Navigation Company, which will be an exact duplicate of the *E. C. Pope.* Length over all, 337 ft.; beam, 42 ft.; hold, 24 ft.; diameter of triple-expansion engine cylinders, 22, 35 and 56 in. Howden's forced draft will be applied to the boilers.

Another steamer of 200 ft. keel, 36 ft. beam and 14 ft. hold for the Lake Superior lumber trade, is to be built at Marine City immediately. Estimated carrying capacity, 1,000,000 ft.

Launch of the "Hudson."—The United States Revenue steamer *Hudson* has been launched from the shipyard of John H. Dialogue & Son, Camden, N. J., and will be used as a boarding vessel in New York Harbor in place of the *Manhattan*. Her bows are strengthened with extra heavy plates and framing to resist the ice, which is a wise precaution in view of this winter's experience.

The craft is an iron hull vessel 97 ft. 6 in. long, 20 ft. 6 in. beam, and 10 ft. 3 in. depth of hold. She is fitted with triple-expansion, surface-condensing engines of 475 H P., having cylinders 13 in., 21 in., and 32½ in. diameter by 24 in. stroke. The steam for the engine will be supplied by a tubular boiler of light weight, which has unusual power for a vessel of this size. The boiler is provided with a fan-blower and a closed ashpit system with a forced draft will be used.

abreast in water-tight compartments, and will give a speed of from 15¼ to 16 knots, the guaranteed speed being 15 knots. The armor will be as nearly impervious to shot as it can be made. The water-line armor belt will be of 18-in. nickel steel and will extend 196 ft. along each side amidships. At the ends of the armor belt is an armored bulkhead athwartships, which is to be 14 in. thick, and above that and the water-line is to be a casemate belt 5 in. thick. The armament will be as follows: Four 13-in. guns, mounted in pairs in the two main turrets; eight 8-in. guns, mounted in pairs in the four turrets at the corners of the casemate; four turrets at the corners of the casemate, four 6-in. guns mounted in broadsides, with splinter bulkheads back of them; twenty 6-pdr. and rapid-firing guns; eight 1-pdr. and Gatling guns and six torpedo tubes. The armament is very heavy for her displace-



DRIVING AXLE-BOX FOR ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

Launch of the "Indiana."—The *Indiana*, the first of the three coast-line battleships, was launched at the Cramp yards in Philadelphia, February 28. She is a high, freeboard ship with water-line armor belt and a heavy protective deck, above which are two armored redoubts carrying turrets. The ship is 348 ft. long on the water-line and 69 ft. 3 in. beam. Her displacement is 10,400 tons, but with a full supply of coal and stores on board she will draw 24 ft. and displace 11,600 tons of water. She will be propelled by twin screws and her engines will be three in number, having 10,000 H. P. The engines will be of the triple-expansion type, will be built

ment, and to some extent the ship is an experiment in that direction.

Trial of a New Solarometer.—Successful experiments have just been made with the solarometer on board the U. S. Lighthouse steamer *Violet*, in the Chesapeake Bay and Baltimore harbor. The solarometer is a nautical instrument, the invention of Lieutenant W. H. Beehler, U. S. Navy. The instrument accurately determines a vessel's position at sea and her compass error by observations of the sun, moon, or stars at any time any one is visible, independent of the visibility of the

sea horizon and without any elaborate calculations. It is mounted on board the steamer and occupies a space of 6 ft. in diameter on the deck. It is arranged with a constant level base a cast-iron float in a large bowl containing 380 lbs. of mercury. The bowl is supported by gimbals on a stand on the deck. The method of observing is to adjust one graduated arc to the declination of the sun or body to be observed as given in the *Nautical Almanac*, and then to turn the telescope to the object in the sky. To get the sun in the axis of the telescope it is necessary to raise or lower the pole of the instrument, and when it is adjusted to be visible in the axis of the telescope, the angle shown by the graduated arc is the vessel's latitude. The latitude, declination and altitude being known, the hour, angle or local apparent time is read on the hour circle, while the azimuth is read on the horizon circle. An index in the line of the keel shows the direction of the true north, and affords means to determine the error of the ship's compass. In a book of azimuth tables, the azimuth corresponding to a certain declination, latitude and azimuth are given. These four quantities must be the same as read from the instrument. Hence, whenever an observation is taken, the observer knows definitely if his results are right or wrong. This feature is peculiar to the solarometer. Further experiments will be made on board the *Violet*. Space for the exhibit of the instrument at the World's Columbian Exposition has been obtained, and the manufacturing of the instruments in quantities will soon be commenced.

The Battleship Iowa.—The *Iowa* will be a formidable battleship. The following are her dimensions: Length on load water-line, 360 ft.; extreme breadth of beam, 72 ft.; displacement at normal draft, 11,296 tons; freeboard forward, 24 ft. The *Iowa* will have engines with a maximum indicated horse-power of 11,000, and she will be able to steam more than 16 knots an hour. She will be able to carry 2,000 tons of coal, and her crew will consist of 436 officers and men. The engines will be rights and lefts, and will be of the vertical, inverted cylinder, direct-acting, triple expansion type. There will be a 39-in. high-pressure, a 55-in. intermediate-pressure, and an 85-in. low-pressure cylinder, each piston having a stroke of 48 in. The working pressure of the boilers will be 160 lbs. to the square inch. The total heating surface of the main boilers will be 23,951 sq. ft., and the grate surface 756 sq. ft. The boilers will be of the horizontal, return 5-tube type. There will be three main double-ended and two auxiliary single-ended steel boilers in the vessel. The battery will be a particularly heavy one and will consist of four 12-in. breech-loading rifles, eight 8-in. breech-loading rifles, six 4-in. rapid-fire rifles, twenty 6-pdrs., four 1-pdrs., four Gatling guns, and 1 field gun. There will be two barbette turrets—one forward and one aft—for the 12-in guns. Four barbette turrets—two on each broadside—will contain the 8-in. rifles. Four of the 4-in. guns will be in armored sponsons on the gun-deck, and the other two will be on the bridge at the extreme end of the superstructure. The 6-pdrs. will be distributed about on the gun-deck, the bridges and superstructure. Two of the 1-pdrs. will be placed in the military tops with the Gatling guns, and two will protect the extreme end of the gun-deck. The hull of the *Iowa* about the water-line region will be protected by a side armor belt 14 in. thick and an average width of 7 ft. 6 in. The hull will be of steel unsheathed. The vessel will have a double bottom and water-tight compartments extending 10 ft. above the load water-line. She will carry no sail and will have but one military mast. The barbettes and turrets for the 12 in. guns will be 15-in. thick. The conning tower will have steel sides 10 in. thick and an armored communication tube 7 in. thick. The barbettes for the 8-in. guns will have a maximum thickness of 8 in. The 4-in. guns will be protected by stationary steel shields, which are really parts of the hull, as they are built into it, forming armored sponsons. Shields and extra side plating will afford protection for the smaller guns. The deck will be of steel of a minimum thickness of 3 in. Transverse armor and a cellulose belt will add to the protective quality of the ship.

REPORT ON THE "VESUVIUS'S" GUNS.

FOLLOWING are the conclusions of the Board appointed to examine the guns and the operation of the gun mechanism of the *Vesuvius*.

In the endeavor to determine the value for naval warfare of the pneumatic guns for discharging torpedoes installed on board the *Vesuvius*, the question of accuracy attracts most attention. Thirty-one of the projectiles fired by the Board for range were dummies and 21 were service projectiles, which, being turned on the outside, are smoother than the dummies. This difference of surface may perhaps affect the range somewhat, but its influence if any did not appear.

After an extended consideration, the Board has decided that, while the accuracy of these guns leaves a good deal to be desired, it is still reasonably sufficient for the purposes of naval warfare in comparatively smooth water, the only condition under which the Board has been able to carry on the tests. The value of the guns is increased by the fact that the projectile contains a heavy charge of high explosives, and also that this explosive can be safely discharged when the projectile that contains it is armed with a fulminate fuse; and though the particular fuse used in the trials has failed to perform its functions, it is evident that it can be safely fired from the gun.

One of the chief merits of the system is that its usefulness begins at about the range where that of the automobile torpedoes now in vogue ceases; and while it is true that daylight is necessary in order to best utilize these ranges, it is thought that a vessel so armed would still be useful at night for annoying groups of hostile ships, firing upon harbors, dockyards, etc. The usefulness of the system at night is increased by the fact that there is no flash or smoke from the guns, and that the report when projectiles are used is comparatively light; indeed, with the vessel to leeward, or if a side wind of moderate force should prevail, it is doubtful whether the report would be much noticed. In the day-time a vessel carrying such guns could successfully attack under cover of fog or smoke or under the shelter or protection of our armored or other ships; she could also be conveniently used in rivers or bays by firing from behind trees or points of land, from which positions she would be able to make fair practice, and owing to the absence of smoke would not be so readily discovered as other vessels.

The Board is aware that the firing of high explosives from powder guns of late years has made progress, and very likely before long the firing of heavy charges from such guns may be generally introduced, and, if so, it is quite probable that the value of the pneumatic guns may be lessened; but it is to be observed that such powder guns have not yet made their appearance in the Navy, and it is uncertain when they will do so. When they do appear perhaps they may prove to be simpler in mechanism and more accurate in practice than the guns of the *Vesuvius*, but the Board has no positive evidence on this point at present, and therefore is uncertain to what extent this superiority may obtain, and are also uncertain to what extent the pneumatic system may be improved. In order to form a judgment as to the comparative accuracy of the two kinds of guns, it would be well to compare the probable rectangles, etc., of the pneumatic guns with those of a rifled mortar or howitzer that would project equal weights of high explosives over equal ranges. But however these matters may ultimately be decided, the Board is of opinion that the pneumatic system, as installed on board the *Vesuvius*, is, on the whole, of decided value in naval warfare, though the fuse is quite defective, and several other points connected with the mechanism of the guns require attention. It is also thought, judging from the comparatively superior endurance of the middle gun, that the system is capable of mechanical improvement, and that the guns can probably be made to work more nearly together than they do now.

The Board has observed the following points in which improvement would be desirable as tending to the most perfect working of the system.

The fiber buffers used in the mechanism do not appear to resist well the hammering of the parts which they cushion; they also appear to swell and flake when much moisture is present, and thus the range and accuracy of the guns is injuriously affected. The buffers should, if possible, be made of some harder and more durable substance.

It would be well if some means were taken to prevent the entrance of undue amounts of moisture into the system, as the presence of moisture affects the buffers as above mentioned.

Valves should be provided to isolate each gun from the others and from the firing reservoirs, in order that a disabled gun could be thrown out and repaired while the others were in use.

SPECIAL TOOLS OF THE DELAWARE & HUDSON CANAL COMPANY'S SHOPS.

THE principal repair shops of the Delaware & Hudson Canal Company are located at Green Island, opposite Troy, N. Y., where the main work for the northern divisions is done, and at Oneonta, midway between Albany and Binghamton, on the Susquehanna Division. The general run of tools in the Green Island shop have been in their places for several years, but continual additions are being made in the shape of special tools of home manufacture, some of which we illustrate in this con-

nection, and will continue the subject in one or two more issues to follow.

It is needless to recapitulate the standard tools in use, for they are such as are to be found in every well-regulated shop; we will, therefore, confine ourselves to the special features of the establishment. The tool room is on one side of the shops, and is equipped with emery grinders, a milling machine of home construction (which we will illustrate in our next issue), and two revolving racks, made like the revolving book cases which are to be found in so many libraries and offices. These racks have five shelves each, which are about 4 ft. in diameter, and possess the advantage of occupying but little wall space, besides enabling a man to stand in his tracks and look over the whole stock of tools and forgings.

The day upon which our visit to the tool-room was made was a cold one in March, but into the oil-hole of the back gearing of one of the lathes there was stuck a slip of a geranium leaf and a brilliant flower. It seemed a little out of place, but spoke well for the taste of the workman, whom we supposed had brought it from home. Our surprise was increased, however, when the next step took us into a well-appointed conservatory filled with a vigorous growth of tropical and the ordinary flowering plants of our summer gardens. The company maintains conservatories at Green Island and Oneonta, where thousands of plants are cared for during the winter, and which are used during the summer for decorating the grounds of the shops and the stations along the line. The work was

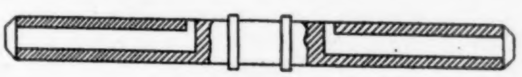


FIG. 1

started, we believe, by Mr. Cory, the Master Mechanic at Green Island, who converted the location of a wild-looking scrap heap into a small hot-bed by means of a few old window sashes. His plants grew and gained in the favor of officers and men, with the result we now find. And curiously enough, Mr. Cory at Green Island and Mr. Smith at Oneonta are both positive in their assertions that this cultivation of flowers results in an actual saving to the company by the spirit inculcated into the men that neatness is the order of the place.

But returning to the purely mechanical features, we illustrate a few handy shop tools that were sketched at Green Island.

Fig. 1 is a section of a convenient form of a rose reamer, for use in a lathe. Any one who has used such a tool in this place knows the difficulty of getting oil down to the bottom of the hole and cutting edges of the tool. In this device there is a hole drilled in some distance from the end, into which a side hole leads, through which the oil is introduced. The central portion is flattened for the purpose of more convenient holding with the dog. The reamer shown is of the double-ended variety.

Figs. 2 and 3 show a plan and back elevation of a convenient form of tool holder for carrying two cutting-off tools at the same time. At the Green Island shops it is used for cutting off cylinder packing rings. It consists merely of a piece of 4 in. × ¾ in. iron bent to the shape shown in the elevation, and drilled and tapped for the two set screws on the side. The tools are held to the proper distance apart by a separating strip planed to the proper thickness.

Fig. 4 illustrates a convenient form of boring bar for driving-boxes. It is 2½ in. in diameter, and has a spline laid in it from end to end. A sliding head, shown by the cross-hatched outline, slides over it. At one end it is recessed to receive the tool shown in fig. 5. The center hole in the tool admits a screwbolt by which it is fastened to the head. The two smaller holes on either side are threaded and furnished with set screws, which bear against the bottom of the tool slot and

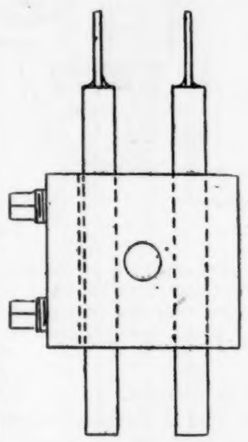


FIG. 2.

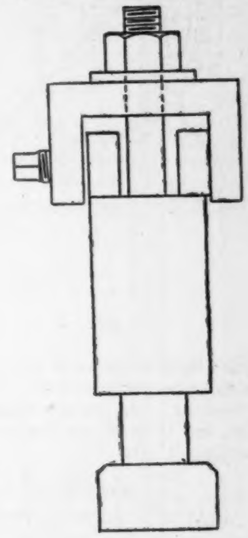


FIG. 3.

serve to make the adjustments for the proper gauging of the tool to the cut. The driving-box is strapped to the body of the lathe, while the head is driven for feed by an offset bar held in the tool post, as shown in the engraving. The wrinkle is doing such excellent work that it is well worth copying.

In the Oneonta shops there is a home-made pipe-cutter and threading tool, shown in figs 6, 7 and 8. Fig. 7 is a side elevation. The pipe is held by the vise A, which is shown screwed together in fig. 8, and which with its whole frame can slide ahead on the bars B B. The dies are placed in the chuck C, which is held upon a hollow spindle that is driven by the gear D. Hand-power is used to drive it at present. The large pinion at the right being used for the smaller sizes of pipe, but when anything above 1½ in. in diameter is to be cut or threaded, this pinion is slipped out of mesh with the gear and the small one brought into play. This latter can also be thrown out of mesh when it is not in use. The machine stands upon

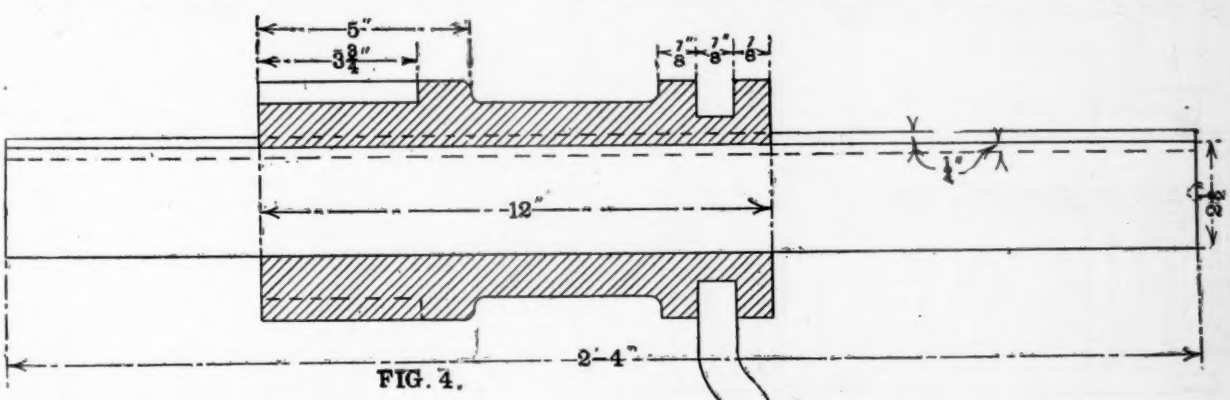


FIG. 4.

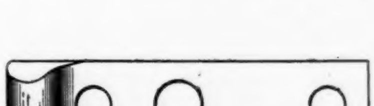


FIG. 5

a bench, and the general size may be estimated from the fact that the pitch circle of the main gear is 21 in. in diameter.

There is also to be seen about the Oneonta shops a very strong and convenient form of hand-truck, of which we give engravings. While there is nothing startlingly novel about it, it serves its purpose well, and we present it because it may

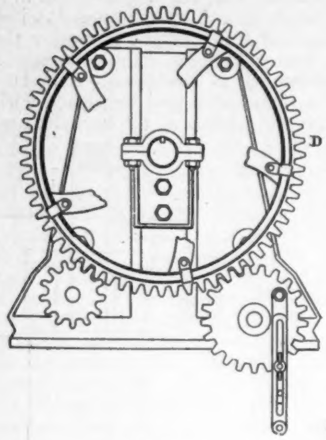


Fig. 6.

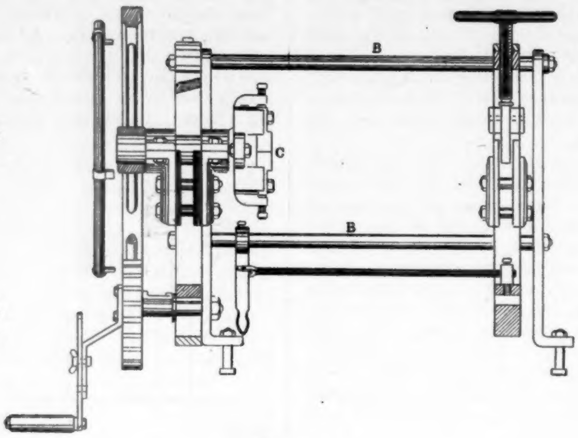


Fig. 7.

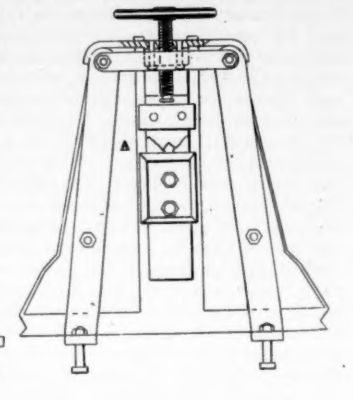
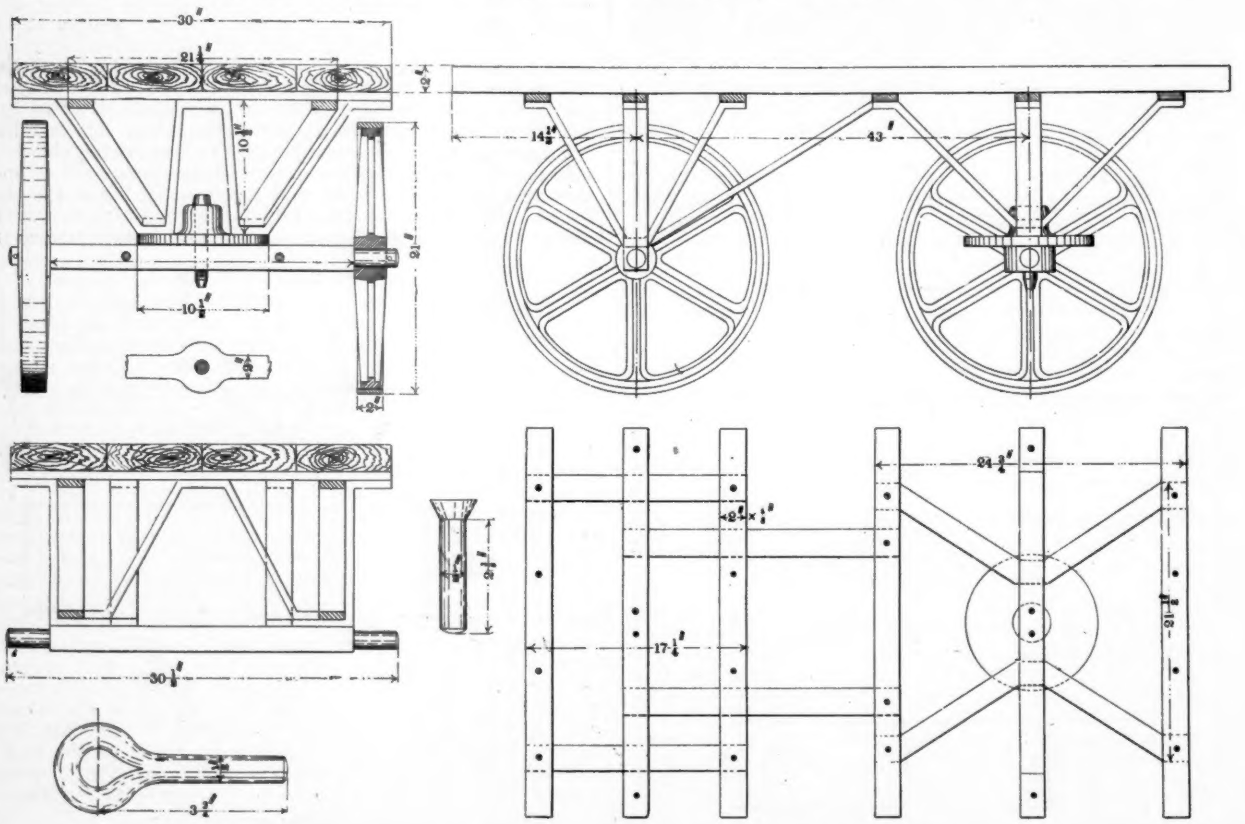


Fig. 8.

save time to some of our readers who need such a convenience and who have neither the time nor opportunity to make a drawing. As the drawings show the construction very clearly, and as most of the dimensions are given, we may pass on at once to the

HYDRAULIC CRANE FOR CAR WHEELS.

Hydraulic power is very extensively used at Oneonta, Green



ONEONTA SHOP TRUCK, DELAWARE & HUDSON CANAL COMPANY.

Island and Whitehall, and we shall publish a number of interesting tools that have been built at the shops in which a water pressure is used as the motive power. The water is usually taken from the village or city mains, which are under a constant pressure of from 75 lbs. to 90 lbs. per square inch. But when the pressure falls below these figures for any reason, there is a pump in the shop which is utilized to maintain that required for the operation of the hydraulic machinery.

The crane here illustrated is one that stands between a couple of wheel borers in the Oneonta shops. The post consists of a length of wrought pipe closed at the bottom and furnished with a step. Water is admitted at the top and led off near the bottom at a convenient height for the man operating it to handle the valves. The cylinder, which is held rigidly by the two arms, has an internal diameter of $4\frac{3}{4}$ in., with a shell $\frac{5}{8}$ in. thick. The stroke is 5 ft. 3 in. The piston-head is provided with a double leather packing, so that in case the friction is too great for the unloaded tongs to lower, a pressure can be admitted at the top to force the piston-head down. The work is done rapidly and silently, about two seconds being required to lift a wheel from the floor. The lift being direct, there is nothing at all to get out of order.

HYDRAULIC BOOM CRANE.

This crane stands out of doors at one end of the Oneonta shops, and is used principally for loading and unloading shop materials and supplies, a large proportion of the work consisting of the handling of car wheels. The construction is exceedingly simple. There is a solid hollow mast, beneath and central with which is the direct acting hydraulic cylinder with a

stroke of 7 ft. 10 in. The piston of this cylinder, also, has a double leather packing, so that it may be forced up in case the frictional resistances are too great for the empty chain to haul it. The cap of the post has a male center which takes a collar at the inner end of the boom and carries the horizontal pull due to the load. The thrust at the foot is taken by two rollers, one on either side of the strut, which travel over a track cast on the base of the column. A four-way valve is used, a section of which is given. It will be seen that the pressure may be admitted to the top or bottom end of the cylinder, and the exhaust water let off from the opposite end at the same time.

Persons who have had no experience with the use of hydraulic machinery are apt to think that in this climate there is great danger of freezing; but this is not the experience on the Delaware & Hudson. This crane is out-of-doors, and though the past winter has been one of unusual severity, there has been no trouble from freezing. The only precaution that was taken was to lay bare a steam pipe which passed through the pit.

The above are a few of the many interesting features to be found in and about these shops, the illustrating of which will be continued in our next issue.

THE EFFECT OF TEMPERATURE ON THE STRENGTH OF IRON.

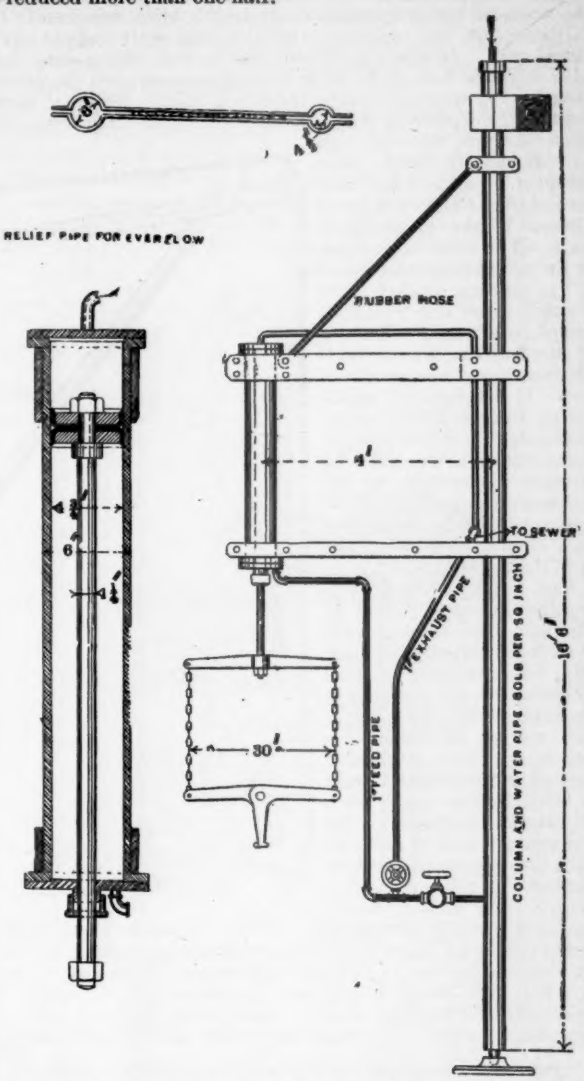
This subject has attracted considerable attention on account of its importance in connection with steam boilers and other structures that are exposed, when in use, to a temperature several hundred degrees higher than the ordinary temperature of the air; but notwithstanding the interest that engineers have taken in the matter there seems to have been but little done in the way of experimental investigation.

The first experiments bearing upon the influence of temperature on the strength of iron, so far as we know, were those made by the Franklin Institute, in 1833, and published in the *Journal* of that institution in 1837. There is a difference of opinion among the authorities as to what these experiments really show, but they have usually been considered to show that iron grows stronger when its temperature is raised from, say, 60° up to 500° Fahr. Chief Engineer Isherwood of the U. S. Navy has criticised the method in which they were carried out, and has pointed out a source of error to which they are doubtless liable.

Ten years later, in 1843, Baudrimont made a series of experiments with wires of gold, platinum, copper, silver, palladium and iron. According to Isherwood, Baudrimont's average results for iron were as follows: Strength of iron wire, per square inch of section, was 295,000 lbs. at 32° Fahr., 279,000 lbs at 212° Fahr., and 301,000 lbs. at 392° Fahr. These results are interesting, but they are of no particular importance, because iron wire is a very different thing from boiler-plate, or bar iron.

In 1856 Sir William Fairbairn published the results of his experiments. They indicated that the strength of common boiler-plate is not materially affected by ordinary changes in temperature, but that as a dull red heat is approached the tensile strength falls rapidly. He says: "I have completed a series of experiments on wrought-iron plates and rivet-iron at various temperatures, from 30° under the freezing-point to red heat. These experiments are the more satisfactory as they exhibit no diminution of strength from 60° to 400°; but an increase of heat from that point to a dull red heat shows a considerable reduction of strength and a great increase of ductility, the plates being in the ratio of 20.3 to 15.5 tons per square inch, as regards strength, and the rivet-iron as 35 to 16. The iron suffers little or no diminution in its powers of resistance up to a temperature of 500° Fahr."

Next in order, after Fairbairn's experiments, came those made by the British Admiralty at the Portsmouth (England) Dockyard, in 1877. The specimens to be tested were heated in an oil bath, and "the dies for gripping them were also so heated. The process of fixing and breaking occupied about one minute, during which care was taken to prevent, as far as possible, loss of heat by radiation and conduction." The temperature of each test-piece was recorded as equal to the temperature of the bath in which it was heated. Owing to the cooling of the specimens, and the suddenness with which they had to be pulled apart in order to compress the whole experiment into one minute, we cannot consider this series of tests to be very satisfactory, although it made an acceptable addition to what was then a very meager knowledge of the effect of temperature on the strength of iron. The general conclusions that were reached by the committee having charge of these tests were as follows: "Wrought-irons, Yorkshire and re-manufactured, increase in strength up to 500°, but lose slightly in ductility up to 300°, after which the ductility increases up to 500°, at which point it is still less than at the ordinary temperature of the air. The strength of Landore steel is not affected by temperature up to 500°, but its ductility is reduced more than one-half."



HYDRAULIC WHEEL LIFT, DELAWARE & HUDSON CANAL CO.

Results of Dr. Huston's Tests in 1877.

Material Tested.	Thickness.	Net Width.	Net Sectional Area.	Breaking Weight.	Strain per sq. in. of Original Area.	Strain per sq. in. of Fractured Area.	Averages of these Strains.	Contraction of Area.	Temperature of Specimens.
	In.	In.	sq. in	Lbs.	Lbs.	Lbs.	Lbs.		
Cold blast iron.	0.385	0.622	0.239	12,500	52,300	70,600	61.450	.26	68° F.
" "	.385	.629	.242	16,200	66,940	87,600	77,270	.24	575°
" "	.380	.622	.236	16,550	70,130	90,000	80,065	.22	925°
Otis steel......	.335	.642	.215	12,000	55,800	113,200	84,500	.50	68°
" "	.345	.639	.214	14,200	66,350	111,000	88,675	.40	575°
" "	.335	.640	.214	13,750	64,250	94,830	79,540	.32	925°

In the same year (1877) Dr. Charles Huston of the Lukens Rolling Mills, Coatesville, Pa., made some tests bearing on this question, at which we were present by his invitation. As they have never been published it may be of interest to give a brief account of them. The test strips were a little less than 1 in. wide and about ⅜ in. thick, and through the middle of each piece a ½-in. hole was drilled. These holes were filled with fusible alloys, whose melting points were determined beforehand with considerable accuracy. By reducing the sectional area of the piece, the hole also determined

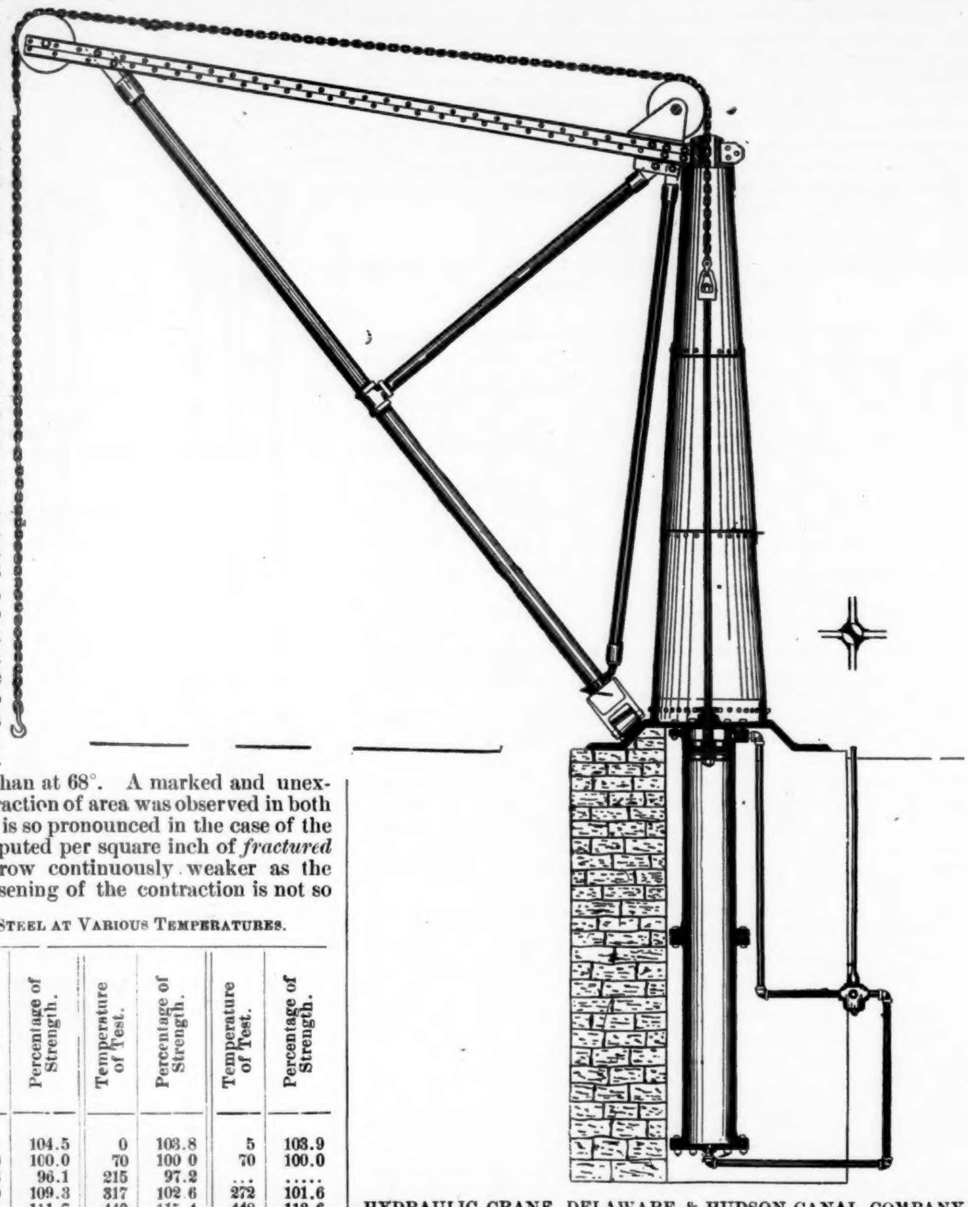
the point of fracture. In making a test the piece was fixed in the jaws of the testing machine, and warmed along the central portion, as uniformly as possible, by a Bunsen burner. The piece was gradually put under tension at the same time, and when the strain upon it had approached its tensile strength the machine was stopped until the fusible alloy was seen to be fairly melted, and the piece was then broken by a slight additional pull. It was considered that in this way a very fair idea might be had of the effect of temperature upon the pieces tested. Six specimens were fractured in all. Three of them were cut from plates of the best flange boiler iron, made from cold blast charcoal blooms, and the remaining three were samples of Otis steel, furnished by the Baldwin Locomotive Works of Philadelphia. The results are given in the accompanying table.

The column headed "net width" gives the width of the piece after the diameter of the hole has been deducted and the "net sectional area" is obtained by multiplying the net width by the thickness. It will be noticed that the iron shows a material increase in strength as the temperature rises. At 78° it broke at 52,300 lbs. per square inch of original section, but at 575° an additional stress of 7 tons per square inch was required in order to break it. The iron even shows a gain in strength between 575° and 900°, but it is doubtful if all pieces would show a gain in strength at this place, for at 925° we are approaching a red heat. The steel also showed a pronounced gain in strength per square inch of original section, as the temperature rose from 68° to 575°, but after this point was reached it fell off again, though even at 925° it remained materially stronger than at 68°. A marked and unexpected falling off in the contraction of area was observed in both the iron and the steel. This is so pronounced in the case of the steel that if the strain is computed per square inch of *fractured* area the steel appears to grow continuously weaker as the temperature rises. The lessening of the contraction is not so marked in the iron test pieces, so that these exhibit an increasing strength whether the original or the fractured area is considered. Although these experiments were not numerous enough to serve as the basis of any very broad generalizations concerning the effect of temperature on the strength of iron, we considered that they showed that iron is *at least as strong* at boiler temperatures as it is at the ordinary atmospheric temperature; and hence we felt safe in designing boilers without regard to the possible change in tensile strength that the metal might experience when heated to 300°, 400°, or even 500°.

THE TENSILE STRENGTH OF STEEL AT VARIOUS TEMPERATURES.

Temperature of Test.	Percentage of Strength.	Temperature of Test.	Percentage of Strength.	Temperature of Test.	Percentage of Strength.	Temperature of Test.	Percentage of Strength.	Temperature of Test.	Percentage of Strength.
0°	104.8	0°	104.3	0°	104.5	0	103.8	5	103.9
70	100.0	70	100.0	70	100.0	70	100 0	70	100.0
195	97.2	201	96.1	223	96.1	215	97.2	...	.....
334	117.4	306	100 3	339	109.3	317	102.6	272	101.6
460	125.8	437	111.9	431	111.7	440	115.4	448	113.6
492	122.2	545	116.8	569	116.4	570	115 9	503	115.6
616	123.4	668	114.5	651	106.4	642	112.8	594	115.4
741	102.5	736	101.4	738	103.1	757	106.0	712	98.1
845	108.4	869	86.2	832	102.0	....	... .	861	94.0
934	81.0	959	72 3	960	85.6	912	85.5	....	.....
...	....	1050	57.2	1021	68.5	1020	75.3	...	.....
1045	47.3	1176	39.2	1198	45.1	1192	43.7	1113	54.5
1235	33.0	1397	30.7	1351	38.7	1395	42 9	1319	35.6

The most extensive series of tests bearing on the effect of temperature, so far as we know, are those carried out recently at the Watertown Arsenal, with the great testing machine. The specimens were heated by rows of Bunsen burners, which were arranged in a muffle; and the temperatures of the test specimens were inferred from their observed expansions. Each piece was heated to the temperature of the test before being strained, and its expansion was observed by a micrometer. The coefficient of expansion of each grade of metal had been determined before the tests began, so that the temperatures could be inferred with considerable precision. It will be impossible to give the results of these tests in detail in this place, but the foregoing abstract of five of them shows quite well that the strength of steel is greater at about 500° Fahr. than it is at 70°. The temperatures are all on the Fahrenheit scale.



HYDRAULIC CRANE, DELAWARE & HUDSON CANAL COMPANY.

These five series of tests were made with five different qualities of steel, containing, respectively, .09, .20, .31, .37, and .51 per cent. of carbon. The figures given in the columns headed "Percentage of Strength" were obtained by dividing the tensile strength of a sample of steel at the given temperature by the strength of the same quality of steel at 70° Fahr.

It will be seen that these specimens were all stronger in the neighborhood of zero than they were at ordinary temperatures; and that, in fact, they all show a *minimum* of strength at 210°, or thereabouts, and a *maximum* of strength at about 550°. This curious property of iron may now be considered to be well established; and it deserves further attention than it has yet received.—*Locomotive.*

SHELLS WITH HIGH EXPLOSIVES.

As the Dashiell mechanism for quick-firing guns of large caliber has been adopted by our Navy, we give below a description of it, taken from the *Annual No. XI.* of the Office of Naval Intelligence, supplementing it by a description from the same source of the Fletcher mount for large rapid-fire guns. It may be noted here that the use of rapid-fire guns of large caliber is a marked feature in recent changes in naval ordnance.

THE DASHIELL MECHANISM FOR RAPID-FIRE GUNS.

The fermeture is on the slotted-screw system. The plug is supported, when withdrawn, on a hinged tray and collar of suitable shape. All the operating mechanism is carried on the tray casting, except the trigger, which is on the gun.

A curved translating arm of bell-crank lever form is pivoted to the tray at one end. A vertical toe at the other end engages an undercut score in the breech plug. When this lever swings on its pivot, the plug, if unlocked, will be withdrawn from or entered into the breech.

In the elbow of this arm is pivoted a horizontal cogged segment, formed in one piece, with a long lever ending in a vertical handle, or grip. A curved slot in the tray allows its pivot-pin to move with the pivot of the translating arm as a center during longitudinal motion of the plug on the tray. This cogged segment engages a series of horizontal cogs on a rack bar which slides in a groove in the front of the tray. The left-hand end of this bar is provided with vertical cogs engaging another series on the lower part of the breech plug. A stop-pin on the face of the breech limits the travel of the rack. The length of the rack is such that its extreme right-hand cog is immediately below the pivot-pin of the translating arm when the plug is unlocked.

The usual double-acting latch is fitted to the tray.

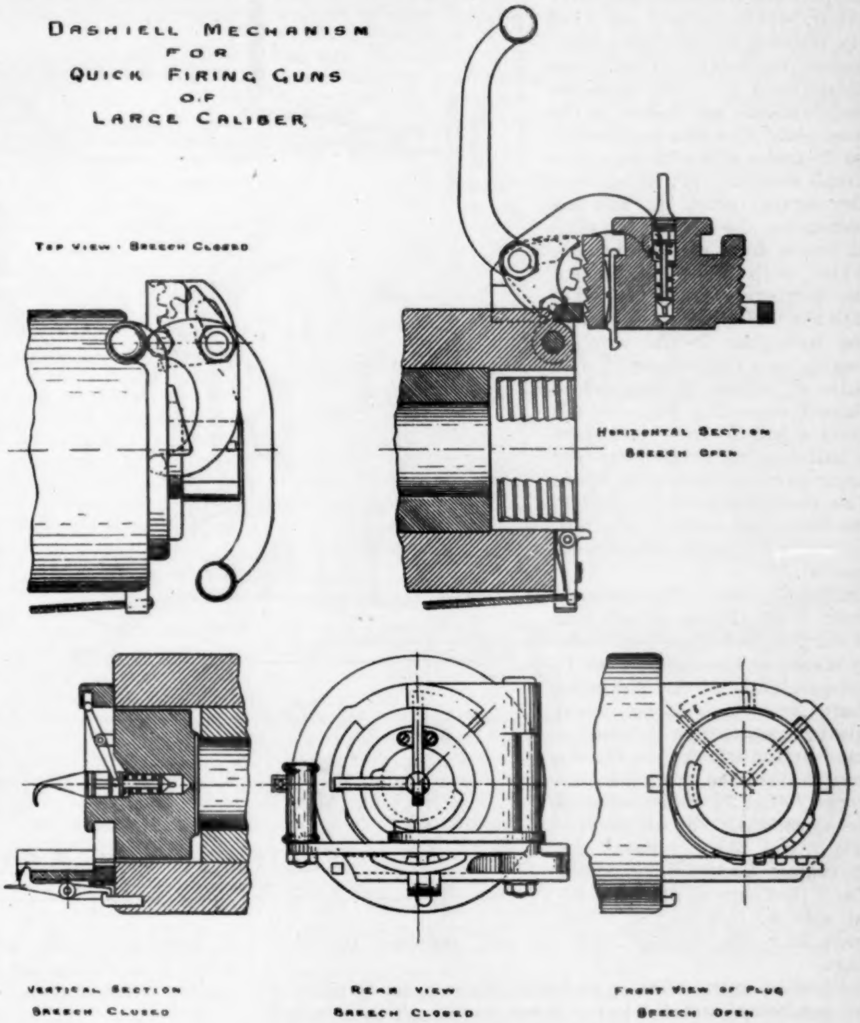
The plug being locked, a pull on the hand-lever rotates the cogged segment, thus unlocking the breech plug by means of the rack-bar described. As soon as the plug is unlocked the stop-pin will have checked the motion of this rack, and the center of motion will be transferred to its right-hand cog, which is now immediately below the pivot-pin of the translating arm. The arm and lever consequently swing together, and the plug is withdrawn on the tray and swung to one side clear for loading. As the plug comes out a groove cut in its threaded lower segment passes over the central tooth of the rack.

In returning the plug to the breech two forces will be at work in the mechanism—one to rotate the plug, the other to push it home. The first is checked by the groove in the plug engaging the tooth of the rack mentioned and pulling the plug against the tray-rib. Only the motion of translation can thus take place. As soon as it is entirely off the tray-ribs the plug can revolve, but being then home in the breech its translating motion ceases and revolution locks it in place.

The extractor is a strong bar kept down by a mild spring. It passes through a hole in the plug so as not to interfere with the threaded parts. By utilizing a certain amount of fore-and-aft lost motion the extractor is kept from slipping off the cartridge-head at the same time that the plug, when pulled quickly to the rear through this lost distance, acts very powerfully as a hammer to extract the empty case.

The extractor is shown in its forward or pulling position. When pushing a cartridge home the extractor-hook cannot rise and catch until it has been pushed back, by the forward motion of the plug, to its rear position. It can then snap over the rim of the case, and is ready for the blow from the breech plug in extraction.

The firing mechanism consists of a straight firing-pin, with cone-shaped shoulder and finger-hook. A spiral spring actuates it, being held to its work by a loose, spool-shaped sleeve. A cocking-lever is pivoted to the plug, its upper end running along a cam groove in the tray collar, while its lower end is forked to engage over the spool-shaped sleeve on the firing-pin. When unlocking this lever moves the sleeve to the rear, cocking the pin on the toe of a horizontal sear-bar. When locking, the sleeve is given motion in the opposite direction, which compresses the spring, leaving the firing-pin cocked. When fully locked, the outer hook of the sear engages the trigger.



It will be seen that the gun cannot be fired unless the main-spring is compressed and the sear and trigger engaged, neither of which takes place until the last instant of locking.

The lanyard leads forward, around a pulley near the trunnions if desired, so that the gun captain and lanyard will be out of the way of the gun servants about the breech, and the pull for firing will be independent of the elevation of the piece.

The advantages claimed for this mechanism are efficiency and cheapness of manufacture. The quick-acting part is applicable to any gun with slotted screw fermeture in which the breech-plug is worked by manual power.

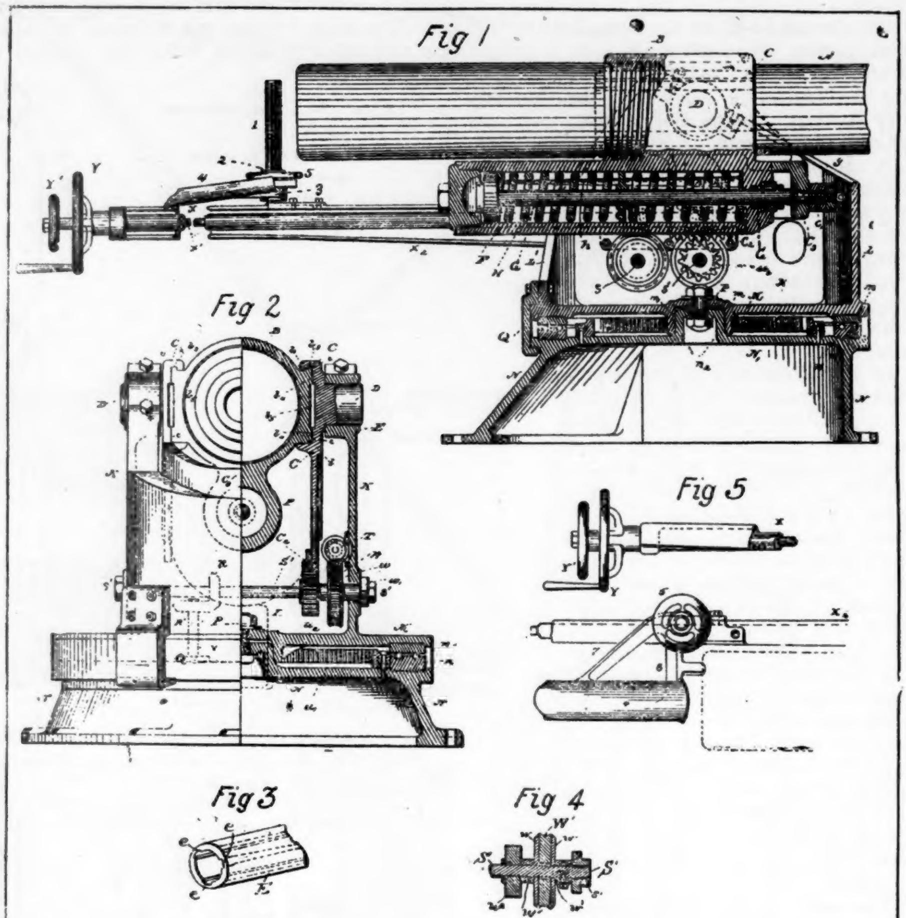
Five rounds have been fired in 17 seconds from the naval 4-in. gun fitted with this mechanism, the gun's crew having been drilled for two minutes before the salvo was fired.

RAPID-FIRE GUN MOUNT.

The rapid-fire gun mount designed by Lieutenant F. F. Fletcher, U.S.N., has been so modified that a description of it as finally adopted for the 4-in. rapid-fire guns is given, reference being made to the accompanying drawings.

Carriage.—The band B screwed on the gun at its center of gravity has cast on its under side the recoil cylinder F, and on its side the lugs b_1 b_2 and b_3, figs. 1 and 2. These lugs slide in corresponding recesses in the sides of the rocking frame C, which frame takes the weight of the gun, furnishes the trunnions D, and acts as the guide during recoil. The upper carriage is composed of the two side-brackets K, which support the trunnions and carry the transverse axles S and S^1 of the training and elevating gear, and of the front and rear transoms L and L^1. The transoms and brackets are bolted to the base-plate M, which is provided on its under side with the cylindrical shoulder m^1, fitting over the central pivot n_2, and has bolted on the outside the clips Q, two in front and one in rear, which, with the bolt D, prevent the carriage from lifting. Let into the under circumference of the base-plate is the ring m, resting on a double row of steel balls n^1, which fill grooves in the corresponding ring n of the pivot stand N, thus providing a ball-bearing surface for the upper carriage to revolve upon. The pivot stand N is bolted to the deck, and carries the circular rack u^1, for training in direction.

Training gear.—The training shaft X (fig. 1), on the left side of the gun, is hollow, and works by means of the hand wheel Y, independently of the elevating shaft X^1, which is contained within it and which is manipulated by the wheel Y^1. On the front end of the shaft X is the worm T (fig. 2), which actuates the worm-wheel W, on the rear axle S, and, through them and the pinions R and R^1, the cogged wheel (not shown) on the vertical axis v; this cogged wheel gears into the circular rack u^1, and revolves the carriage.



FLETCHER 4-inch R.F. Gun-Mount.

Elevating gear.—Cast in one with the rocking frame C is the quadrantal arm C^1, to the lower end of which is bolted the cogged arc C_2. Keyed to the forward end of the interior or elevating rod X^1 (fig. 1), and in front of the training worm T, is a similar worm working in a worm-wheel on the forward axle S^1 (fig. 1); on this axle is the cogged wheel u_2 (figs. 1 and 2), which, gearing in the cogged quadrant C_2, causes the gun to swing about the trunnions D, as an axis, when the hand-wheel Y^1 is turned.

In order to permit of quick training without the use of gearing, and also to avoid damage from excessive strains, the worm-wheels W and W^1 are loose on the shafts S and S^1, being held by frictional disks. Fig. 4 shows one of these wheels, S^1 being the axle, W^1 the worm-wheel, w w the friction disks, and w^1 w^1 sliding collars which hold, or are in one with the disks; w^2 is a set collar, and s^1 a screw nut. By setting up or loosening the nut, the frictional bearing of the disks may be regulated at will.

Recoil check.—The hydraulic recoil cylinder F (fig. 1), referred to above as being cast in one with the screw-band B, contains the liquid, the piston and rod G, and the spiral spring H for return to battery. The forward end of the piston passes through a stuffing-box in the cylinder, and is secured by right and left-handed nuts c_1 c_2 to the front arm c_3 of the rocking frame C. The spring H is set in place with an initial tension, so that it tends constantly to force the gun into firing position. Grooves of varying cross-section are cut in the interior of the cylinder (fig. 3), by which the flow of liquid from the front to the rear of the piston, during recoil, is controlled.

Loading tray.—A loose collar 3 (fig. 1), on the vertical screw 1, carries, by the arms 7, 8 (fig. 5), the loading tray 4. This tray is swung clear before firing the gun, and into the position shown in fig. 5 after the discharge. It is raised or lowered by the wheel 5 and nut 2 working on the screw 1, so that it can always be brought into position for loading without changing the gun's elevation.

LIQUEFIED ATMOSPHERIC AIR.

Professor Dewar recently delivered an address on Liquefied Atmospheric Air at the Royal Institution. An experiment with liquid ethylene, boiling at − 100° C., showed that the evolution of gas was largely increased by warmth, although the temperature of the boiling liquid remained constant, while on placing the bulb containing the liquid ethylene in a bath of liquid carbonic anhydride, boiling at − 80° C., the evolution of gas was greatly diminished. That conduction rather than convection was the chief cause of evaporation was evident from the fact that if the vessel containing the liquefied gas was surrounded by a highly vacuous space, by being contained in another larger vessel, the annulus being exhausted of air, the liquid might be kept much longer. While the annulus was vacuous, 170 unit volumes of gas were evolved in a unit of time, but when air was admitted into the annulus, 840 unit volumes, or practically five times as much gas, was evolved.

Some experiments were then made with liquid oxygen boiling at − 180° C. It was shown to be a blue transparent liquid

containing some floating particles, probably of solid carbonic anhydride, and its increased stability when placed in vessels surrounded by a vacuum was demonstrated. The lecturer then produced liquefied air in an open tube, which was immersed in a larger vessel containing liquid oxygen—this latter being connected with a vacuum pump, the evaporation of the liquid oxygen causing the temperature to fall to – 210° C. At such low temperatures oxygen will not inflame a glowing taper. Liquid oxygen placed between the poles of an electro-magnet is attracted to the poles on a current being passed. When thrown on the surface of water, it enters into the spheroidal state, a cup of ice being formed beneath it and evaporation taking place quietly; liquid ethylene, however, on being placed in water, gives rise to small explosions. When poured under the surface of water placed in a vessel between the poles of an electro-magnet, liquid oxygen was still attracted to the poles when an electric current was passed through the magnet. Professor Dewar stated that he had not succeeded in obtaining solid oxygen.

Air substantially liquefied as one substance, although at ordinary atmospheric pressures there was at least 10° C. difference in the boiling points of its constituents. When liquid air was placed between the poles of an electro-magnet and the current passed, it was attracted to the poles as a simple body, although nitrogen alone was non-magnetic. On exposure to air in an open vessel the nitrogen distilled off first, the evolved gas being for some time a non-supporter of combustion.

An examination of the optical properties of liquid oxygen showed that the law enunciated by Dr. Gladstone for bodies at ordinary temperatures—that the refractive index divided by the density is a constant quantity—held good for oxygen in the liquid as in the gaseous condition.

The production of these liquefied gases had led to determinations being made of the electrical resistances of substances at extremely low temperatures. It had been found that the resistances of metals diminished to a remarkable extent, and it was very probable that at the absolute zero of temperature (– 274°C.) pure metals would have no resistance whatever, becoming perfect conductors; with alloys very little change occurred as the temperature diminished; while with carbon the resistance increased enormously at the lower temperatures, the minimum resistance being at the temperature of the electric arc—about 3,500° C.

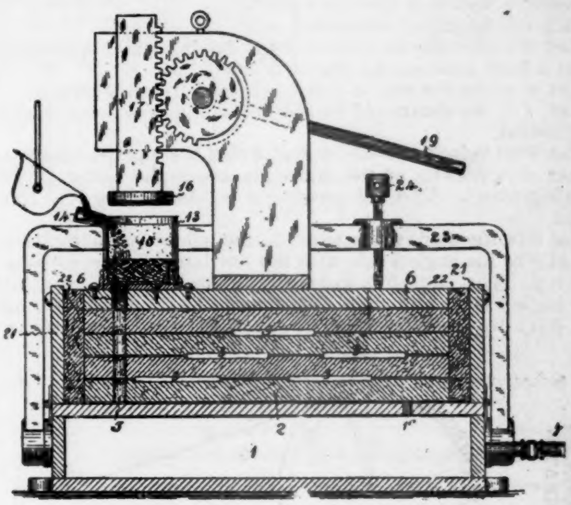
The possibility of obtaining these extremely low temperatures had also been of service in another direction. By carefully filling a tube about 36 in. long and closed at one end with mercury, and then inverting the open end in a trough of the same metal, a space about 6 in. long will form at the upper end. This is vacuous, save for the vapor tension of the mercury at the temperature of the surrounding atmosphere. At ordinary temperatures this pressure is about one-millionth of an atmosphere; at 0° C. (the freezing-point of water) it is one six-millionth of an atmosphere; while at – 80° C. it is only one four-hundred-thousand-millionth of an atmosphere. By placing some mercury in a double-bulbed vessel, boiling the metal to expel air, and sealing the bulbs, a vessel containing only mercury vapor can be obtained. By applying intense cold to these sealed vessels, as by the application of liquid oxygen to their surfaces by means of cotton wool or other suitable absorbents, the mercury vapor will condense and form a mirror on the inner surface of the vessel, and in this manner extremely rarefied vacua, which it is impossible to produce by other means, may be obtained.—*Industries.*

THE SMITH PRESSURE CASTING PROCESS.

SOME remarkable work in fine castings has been done by the Passaic Art Casting Company, of Passaic, N. J., which works under several patents recently granted to John J. C. and Victor E. Smith. The work in bronze, brass and aluminum is very fine, the lightest and most delicate patterns being reproduced with great accuracy and fine finish. The process has not, as yet, been applied to iron or steel.

The casting apparatus, which is shown herewith in section, consists of an air-tight cast-iron box, of suitable size to contain a number of the molds properly piled and packed so as to be immovable in the box. An opening in one end of this box, opposite from the end nearest the sprue, connects it to a large tank, in which a vacuum may be created and maintained by any convenient means. An opening in the cover plate of the box directly connected with the sprue leads into a cylindrical reservoir containing the molten metal. This cylinder is lined with asbestos felt, the hole into the sprue being also covered with it, preventing the exit of the metal from the reservoir, until the proper time. A piston, covered also with asbestos fits closely into the cylinder, and pressure may be applied to it by hand through the action of a lever, rack and pinion, a screw or by other means. The reservoir being filled with the proper quantity of molten metal and the piston entered into the cylinder, connection may be opened between the mold and the vacuum tank, causing the air in the mold to be drawn out, and at the same time pressure of any required degree may be applied to the piston. This pressure bursts that portion of the asbestos lining that lies immediately over the hole in the cover plate, and the metal is instantaneously shot into every portion of the matrix in the mold.

Referring to the engraving, 1 is a chamber under the mold box, which connects with it through the opening 1 *a* and with the vacuum tank through the pipe 7. The molds are shown at 2, their matrix spaces at 3, the sprue at 5, horizontal lines from 3 to 5 representing the channels or gates. The reservoir with its asbestos lining is seen at 15, with the metal runner at 14 and the piston at 16. Between the molds 3 and the sides of the box, 21, there is shown a loam tamping, 22. Screws 24 tapped into the yoke 23 enable the cover or cope to be forced down firmly on the mold. The use of the rack, pinion and lever, 17, 18 and 19, is clearly seen.



SMITH PRESSURE CASTING MECHANISM.

In the words of the patent, "the effectiveness of the above-described method and apparatus for the formation of extremely light and sharp castings having a solidity, homogeneousness and a freedom from blow holes comparable to electro deposited or to rolled metal, is largely attributable to (1) the absolute isolation of the molten mass from metallic surfaces; (2) the disconnection of the molten mass from the molds until the instant of inflow; (3) the effective removal of air, vapor and gases from the matrix spaces and the pores of the molds prior to and during the inflow by communication with a large and continuously exhausted vacuum chamber; (4) the complete hermetical sealing in of the molten metal from the instant of the application of the forcing piston."

One of the most remarkable features of some of the castings is what is known as "undercutting," which is produced in the casting directly from the pattern without the use of cores. In this case the pattern is, of course, not made of metal, as it could not be drawn from the mold, but is of a plastic material like rubber, the composition of which is kept secret. The mixture of materials of which the mold is made is also not made known.

In the use of this process with patterns that have draft and may be drawn from the mold, as in ordinary sand castings, the patterns may be of any metal or other suitable material. The mold in this case may be made of clay of proper constitution, and after ramming in the ordinary way, as in sand molding, it is subjected to pressure in a screw or hydraulic press, so that the material is forced into the finest lines of the pattern. The mold is then taken out of the flask like a pressed brick, dried and baked. The baked pattern is quite porous. Another way of making the molds, which is used for very light and fine work, and also for all undercut work, is to make them of a composition which has plaster of Paris as one of its ingredients. This is poured in a liquid form into the flask containing the pattern, and allowed to set to a certain consistency, when the pattern is withdrawn, and the mold removed from the flask is dried and baked.

The molds as made by either process are in the shape of flat or thin bricks with square edges, so that they may be piled one on top of the other. When so piled the gates of each lead into a central sprue made by a hole through each mold.

THE LOCOMOTIVE PROBLEM.

BY C. H. LINDENBERGER, C.E., DETROIT, MICH.

LET it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 8 ft. and the velocity 60 miles per hour: what is the maximum and minimum velocity of the piston relatively to the earth and not with regard to the locomotive, and when does each occur?

The following is proposed as a solution:

The velocity is a maximum or minimum when acceleration ceases. The latter is either positive or negative. By a negative acceleration is meant the effect of a force that would cause a body to move in the opposite direction if it was at rest.

Let r = radius of the crank-pin.

Let l = length of connecting-rod.

Let t = the time the center of the driving-wheel has moved from a fixed point on the line of railway.

Let u = the distance of this fixed point from the piston.

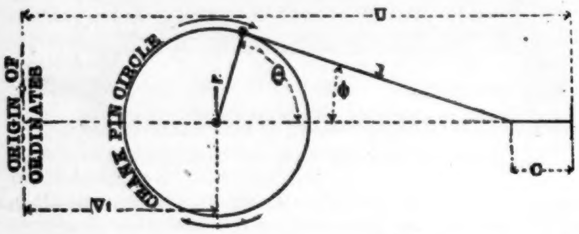
Let c = the distance of the piston from the cross-head, which is constant.

Let V = velocity of the engine, which is supposed constant.

Let v = velocity of the crank-pin about the center of the driving-wheel. This, of course, is constant, since V is constant.

Let θ be the angle made with the horizontal by the radius r.

Let ϕ be the angle made with the horizontal by the connecting-rod. The angle θ is measured in the usual manner, but the angle ϕ is measured in the opposite way. It follows that $\cos. \phi$ is always positive, but $\sin. \phi$ has the same sign as $\sin. \theta$.



For simplicity, the axis of the piston is supposed to be in a horizontal plane with the center of the driving-wheel.

From these definitions

$$u = Vt + r \cos. \theta + l \cos. \phi + c,$$

and differentiating

$$\frac{du}{dt} = \text{velocity of piston} = V - r \sin. \theta \frac{d\theta}{dt} - l \sin. \phi \frac{d\phi}{dt}$$

Now $\frac{r\,d\theta}{dt} = -v$. The negative sign shows that the driving-wheel turns in such a direction as to decrease θ.

$$r \sin. \theta = l \sin. \phi,$$

whence $$r \cos. \theta \frac{d\theta}{dt} = -v \cos. \theta = l \cos. \phi \frac{d\phi}{dt}$$

$$\frac{l\,d\phi}{dt} = -\frac{v \cos. \theta}{\cos. \phi},$$

and therefore

$$\frac{du}{dt} = V + v\left\{\sin. \theta + \frac{\cos. \theta \sin. \phi}{\cos. \phi}\right\}$$

$$= V + v\frac{\sin. (\theta + \phi)}{\cos. \phi}. \qquad (1)$$

The force causing acceleration is proportional to (weight) $\times \frac{d^2 u}{dt^2}$, and the velocity is a maximum or minimum when acceleration ceases, and, therefore, when $\frac{d^2 u}{dt^2} = o$.

Hence, differentiating again,

$$\frac{d^2 u}{dt^2} = o = v\left\{\frac{\cos. (\theta + \phi) \cos. \phi \left(\frac{d\theta}{dt} + \frac{d\phi}{dt}\right) - \left(-\sin. \phi\right)\frac{d\phi}{dt} \sin. (\theta + \phi)}{\cos.^2 \phi}\right\}$$

$$= v\left\{\frac{\left(\cos. (\theta + \phi) \cos. \phi + \sin. (\theta + \phi) \sin. \phi\right)\frac{d\phi}{dt} + \cos. \phi \cos. (\theta \times \phi)\frac{d\theta}{dt}}{\cos.^2 \phi}\right\}$$

$$= v\left\{\frac{\cos. \theta \frac{d\phi}{dt} + \cos. \phi \cos. (\theta + \phi) \frac{d\theta}{dt}}{\cos.^2 \phi}\right\}.$$

$\left(\text{since } \cos. (\theta + \phi) \cos. \phi + \sin. (\theta + \phi) \sin. \phi = \cos. (\theta + \phi - \phi) = \cos. \theta\right)$

Substituting the value of $\frac{d\theta}{dt}, \frac{d\phi}{dt}$ and dividing out common factors, we finally obtain

$$\frac{r}{l} \cos.^2 \theta + \cos.^2 \phi \cos. (\theta + \phi) = o.$$

Now, for convenience, put

$$x = \sin.^2 \theta \quad \frac{r}{l} = A \quad \text{whence } \sin. \phi = A\sqrt{x},$$

and this becomes

$$A(1-x) + (1-A^2 x)\left(\left(\sqrt{1-x}\right)\left(\sqrt{1-A^2 x}\right) - A x\right) = o,$$

and after transposing, squaring, reducing, and cancelling, we get the equation,

$$A^4 x^3 - A^2 x^2 - x + 1 = o.$$

This equation has three real roots; but the only one that is applicable here is the one that is positive, and not greater than unity. It must be noted that the radical sign is ambiguous, so that we will have $\sin. \theta = \pm \sqrt{x}$.

The most convenient method of finding the roots is the trigonometrical formula given in Hymer's "Theory of Equations."

After making the proper reductions and transformations, the following is found to be the solution:

Let $$3\delta = \cos.^{-1}\left(\frac{11 - 27 A^2}{16}\right)$$

then the three roots are as follows:

$$\left(\cos. \delta + \tfrac{1}{4}\right)\frac{4}{3A^2}$$

$$\left(-\cos. \left(\frac{\pi}{3} + \delta\right) + \tfrac{1}{4}\right)\frac{4}{3A^2}$$

$$\left(-\cos. \left(\frac{\pi}{3} - \delta\right) + \tfrac{1}{4}\right)\frac{4}{3A^2}$$

Where π = the length of a semicircle to radius unity, the second of these roots is usually the one we want.

As an illustration, let us suppose that $\frac{r}{l} = \frac{1}{3}$, and the root we want is, therefore,

$$\left(-\cos. (60^\circ + 20^\circ) + \tfrac{1}{4}\right)\frac{4}{3 \times \frac{1}{9}} = 0.9162$$

$$\sin. \theta = \sqrt{0.9162} = \pm\ 0.95718.$$

This is the *sine* of 73° 10′ 22″ nearly.

When the crank-pin radius and connecting-rod are at right angles to each other $\sin. \theta = \frac{l}{\sqrt{r^2 + l^2}} = \frac{3}{\sqrt{10}} 0.9486 =$ *sine* of 71° 33′ 55″ nearly.

So that the maximum and minimum velocity is not for these parts at right angles, as some solutions assume, but is very near that place.

The position of maximum and minimum is deduced as follows: We have seen that $\cos. \phi$ is always positive, and that $\sin. \phi$ has the same sign as $\sin. \theta$.

In equation 1 the coefficient of v is

$$\sin. \theta + \frac{\cos. \theta \sin. \phi}{\cos. \phi} = \sin. \theta \left(\frac{1 + \frac{r}{l}\cos. \theta}{\cos. \phi}\right)$$

and this will have its greatest numerical value when this is a sum instead of a difference.

Its maximum value will therefore be when it is a positive sum and its minimum when it is a negative sum. This will be in the first and fourth quadrants respectively of the circle.

The position for maximum velocity is $\theta = 73° \ 10' \ 22''$, and for minimum is $\theta = 360° - (73° \ 10' \ 22'') = 286° \ 49' \ 38''$.

The coefficient of v in eq. (1) is easily computed, and is found to be 1.05464.

The velocity of the circumference of the driving-wheel is about its center the same as that of the locomotive in space.

This is evident from the fact that it is the same as if the center of the wheel was fixed and the track moved with the required velocity. The velocity of the crank pin is two-sevenths of this, since that is the ratio of the diameters of the circles respectively.

Hence the velocity of the piston in miles per hour is

$$\text{Maximum} = 60 \left(1 + \frac{2}{7}(1.05464)\right) = 78.07956$$

$$\text{Minimum} = 60 \left(1 - \frac{2}{7}(1.05464)\right) = 41.92044$$

For the crank-pin radius and connecting-rod at right angles the coefficient of v is 1.0540926, and the great and small velocities are found to be 78.07016 and 41.92984 respectively. Hence the former is not a maximum nor is the latter a minimum, though they are very nearly so.

Any other ratio of crank-pin radius to connecting-rod may be solved in like manner.

RESISTANCE OF METALS TO SHEAR.

By H. V. Loss, M.E.

(*Continued from page* 144.)

b. Point of Maximum Resistance.

As previously mentioned, an assertion is often being made that this point exists at a penetration

$$d_1 = \tfrac{1}{3}\, t,$$

where t = thickness of bar. After measuring up the cards for steel bars and flat knives, we find that rupture occurs at $\frac{3}{10}$ thickness, varying of course a little on either side of this figure. In the same manner we find with 4° knife the penetration to be $\frac{1}{4}$ thickness. For 8° no average relation can be given, as the variation is very considerable, being $\frac{1}{6}$ thickness for $\frac{3}{4}$ in. bars and $\frac{2}{7}$ thickness for $2\frac{1}{4}$ in. bars, an increase of 100 per cent.

The examined results seem to justify an entire disregard for the width of the bar, the penetration apparently depending mainly on its thickness. The following table gives the average results for steel bars with different thicknesses and bevels.

TABLE NO. 2.

Thickness.	Depth of Penetration at Maximum Resistance.		
	Flat.	4 Degrees.	8 Degrees.
2¼	......	......	.6"
1⅞"	.65"	......	.4"
1¾"	.63" to .65"	.43"	.37"
1⅝"	......	......	.35"
1½"	.44" to .45"	.4"	.25"
1⅜"	43"	......	.2"
1¼"	......	3"	.17"
1⅛"	.37"	......	......
⅞"	......	.2"	.12"
¾"	.25" to .27"	.2"	......

As a general result we may determine the point of maximum resistance for soft steel bars from the following formulas :

$$\left.\begin{array}{l} d_1 = .16\sqrt{t^3} \text{ for } 8° \text{ top knife} \\ d_1 = .25 \ t \quad \text{"} \ 4° \ \text{"} \quad \text{"} \\ d_1 = .3 \ \ t \quad \text{"} \ 0° \ \text{"} \quad \text{" or flat} \end{array}\right\} (1)$$

For iron we find with 8° bevel

$$d_1 = \tfrac{1}{5}\, t \text{ to } \tfrac{1}{4}\, t,$$

with a variation in thickness from 1 in. to 2 in. The experiments on iron were less numerous than on steel, and the relation was therefore in this case not as accurately established.

So far none of the derived results have coincided with $d_1 = \frac{1}{3}\, t$.* Whether this expression is true with regard to flat knives on iron—the only possible case that still remains—was not determined.

c. Point of Final Rupture.

When the maximum resistance has been reached the first detailed rupture occurs. With a flat knife this first distortion is shown on the broken cross section by the well-known features of detailed shear, which characteristics especially are familiar with punching—namely, as an apparent overlapping of material, as if the punch, which, of course, is nothing more or less than a flat shear, had dragged parts of the metal with it in its descent. With a beveled knife the result is somewhat different. The first rupture in this case, as marked by the point of maximum resistance, is generally followed by a break through the entire thickness, starting at the edge and penetrating a certain distance inward, generally from 1 to $1\frac{1}{4}$ in. After the knife has once more proceeded a certain distance downward, the bar is completely severed, and the question may properly be asked : What is this certain distance, as compared to thickness and width when the final rupture does occur? The correct answer must naturally depend upon the dimensions of the bar as well as the angle of knives. Again, examining the original cards, the results hereof is contained in the following tables Nos. 3, 4 and 5. The figures given represent the *total penetration*, or from the time the top knife touched the bar until it broke.

TABLE NO. 3.

Width of Bar.	Thickness of Bars in Inches—8 Degrees Bevel of Knife.													
	⅞"	1"	1 1/16"	1⅛"	1¼"	1 5/16"	1⅜"	1½"	1 9/16"	1⅝"	1¾"	1⅞"	2"	2¼"
4"	.5"	....	.55"	....	....	.....	....	.....	....	.7"	.75"	....	....	.....
5"	...	.65"	....	....	.7"	.. ..	...	.....	....	.8"	.8"	.. .	.. .	.....
6"	.7"	...	...	....	....	.....	.8"	.....	.9"	...	1.00"	1.1"	....	1.15"
7"		....	....	....	....	1.00"	....	.. .	....	....	.....	...	1 3"	.....
8"	....	...	....	..	...	.....	....	1 12"	....	...	1.3"	1.3"	....	....

TABLE NO. 4.

Width of Bar.	Thickness of Bars in Inches—4 Degrees Bevel of Knife.					
	¾"	⅞"	1 1/16"	1¼"	1½"	1¾"
4"	....	.3"	.44"	....	....	.53"
5"	.37"	....	....	.52"	....	....
8"	....	... ..	....	....	.7"	....

TABLE NO. 5.

Width of Bars.	Thickness of Bars in Inches—Flat Knives.						
	¾"	1 1/16"	1¼"	1 3/16"	1⅜"	1½"	1¾"
4"	......	.4"	....	....	....	.5"	.63"
5"	.31"	.. ....	.47"	....	.5"	....	....
6"	....	... .	....	.5"	....	.6"	.7"

For flat bars the stroke may be said to vary from .33 to .4 of the thickness, while a beveled knife has a still greater variation. It will be found, however, that formula (2) gives the stroke or penetration with fair precision for bevels up to 8° and bars up to 8 in. in width. It is possible the range may be still greater, but the writer has had no opportunity for testing it.

If s = stroke and a = bevel of top knife, we have

$$s = \frac{4}{9}\left(\sqrt[3]{t^2} + w \tan a\right) \qquad (2)$$

For a flat knife, with $a = 0$, we should then have

$$s = \frac{4}{9}\sqrt[3]{t^2} \qquad (3)$$

* In practice the value of d_1 is always divided equally between the top and bottom knives, the penetration of each knife always being $\frac{d_1}{2}$.

While the above formulas are, strictly speaking, based on steel with a tensile strength of 65,000 to 75,000 lbs. per square inch, a limited number of experiments on 5-in. iron bars with 8° beveled knife show results that do not vary considerably from those already obtained on the same dimensions in steel, as indicated by table No. 6.

TABLE NO. 6.
Iron Bars—8 Degrees Bevel.

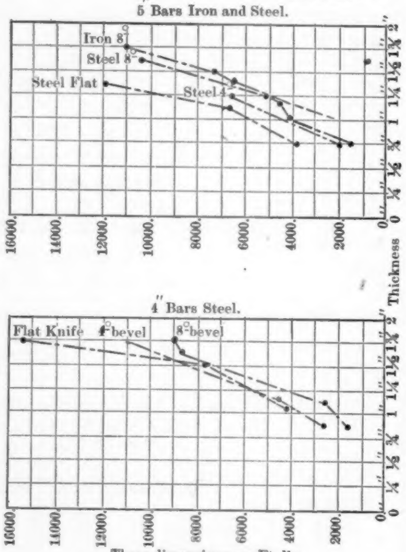
Bars.*	S*
5" × 1"	.5"
5" × 1⅛"	.65"
5" × 1¼"	.78"
5" × 1⅜"	.8"
5" × 1¾"	.9"

d. Energy Consumed.

A vital question in connection with the present investigation is the number of foot-pounds necessary to sever any one bar of given dimensions with a knife of known bevel. That there should be a difference between iron and steel in this respect is to be supposed, although some of the results derived were not at all anticipated in their character. In designing a shear it is not only necessary to know the momentary maximum exertion, which mostly determines the strength of the machine, but if not driven by water, as a common hydraulic shear, an engine or a fly-wheel and pulley has to be attached, in which case *the energy* of the cut to be made will decide the size of the steam cylinder and fly-wheels.

Plate No. 8 gives the energy expended on 4 and 5-in. bars with thicknesses up to 1¾ in. In a general way it is shown very conclusively that the flatter knife requires the greatest energy. It might have been supposed with some degree of probability that the reverse condition would exist, as a more sudden break, while showing a higher momentary maximum resistance, might nevertheless represent a smaller energy due to the decreased penetration before rupture occurs. However, such was not the case, as clearly demonstrated on all cards.

Plate No. 8



These dimensions are Ft. lbs.
Energy Cards for 4 inch & 5 inch bars.
Iron and Steel.

The 5 in. iron bar requires but very little less energy as compared to the steel bar of same dimensions, both being cut with an 8° knife. This is a condition similar to the one existing on the pressure cards of the same sections.

Plate No. 9 shows the energy for 6, 7, and 8-in. bars with results very similar to the ones already considered. The most complete series of experiments was made on the 6-in. bars with 8° knife. The plotted results show here very plainly the quickened increase in energy required as the thicknesses become greater. In this respect the energy and pressure seem both to follow a somewhat similar law, possibly a conic section.

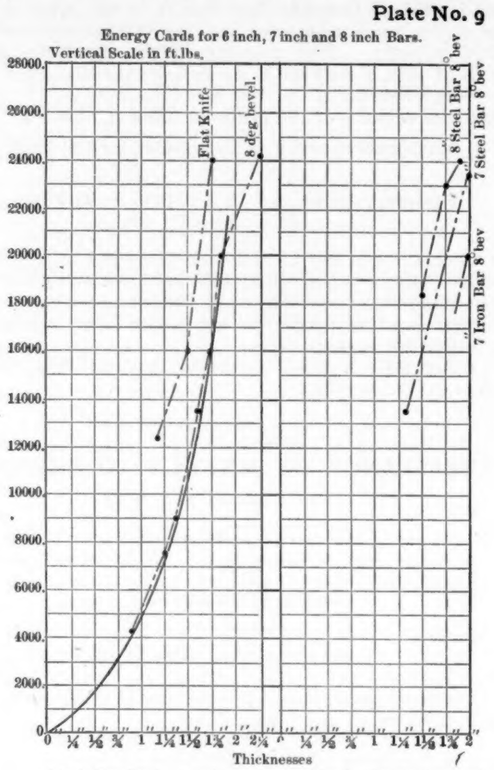
Plate No. 11 shows the energy per inch of width of steel bars with different thicknesses, giving the average results for each thickness on different widths. While maximum pressures, when taken under similar conditions as shown on plate No. 10, vary directly as the thickness, the energies seem to follow a different law, as indicated by the average line being a curve. There is no reason why iron bars under the same conditions should follow a different law, and the results on 5-in. bars will form a guide as to the proper difference to allow for the two materials.

* As with the value of d_1, in determining the point of maximum resistance, so is also here S divided equally between the two knives.

2. Angles.

In cutting material of this shape the relative position and construction of knives are as per sketch, fig. 2, and while the top knife is so designed as to bring it to bear first on the inside corner, this advance is so small as to practically make it a square knife. The purpose of causing the first contact to take place at the center is to prevent the angle from shifting sideways or from turning in the bottom die.

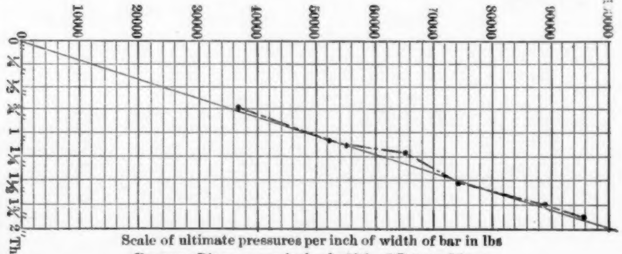
Plate No. 9



6 inch. Bar Steel. 7 inch Bar Iron and Steel. 8 inch. Bar Steel.

a. Ultimate Pressures.

Plate No. 12 shows the pressure per inch of width necessary to cut iron or steel angles of different thicknesses. By an inch of width is understood an inch of that figure which is represented by the sum of the two nominal dimensions of its legs. A 3½ × 7 in. angle has, therefore, a total nominal width of 10½ in., which latter figure, when multiplied by the value, as found on the table to correspond to any given thickness, furnishes the total amount of breaking force in pounds for that dimension. The experiments show some irregularities for iron with ⅜ and $\frac{7}{16}$ in. thicknesses, while the other dimensions, however, give fair results. One of these is, nevertheless, somewhat unexpected—namely, while the experiments



Scale of ultimate pressures per inch of width of bar in lbs
Pressure Diagram per inch of width of flat steel bars.
Flat Knife.

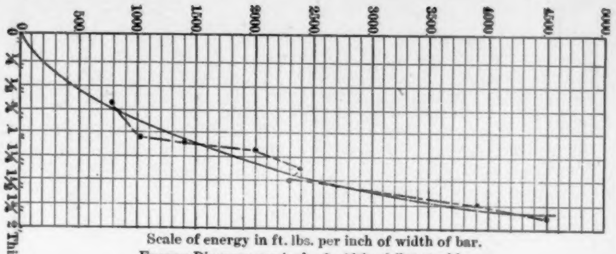
Plate No. 10

on rectangular bars with square knives clearly result in a constant ratio between power and thickness, as shown per inch of width on table No. 10, the plotted results seem in this case to indicate a ratio that is decreasing with the thickness of legs. It would appear that the peculiar cutting action of an angle knife would be responsible for this result.

b. Energy Consumed.

Plate No. 13 shows the energies expended for an inch of width with different thicknesses.

Here is another rather unexpected result demonstrated. *Iron angles require more energy than the corresponding sizes in steel.* In the neighborhood of $\frac{1}{2}$ in. in thickness this difference seems to be a maximum, decreasing as the thicknesses are increasing, and it would appear as if all difference would cease at about 1 in. in thickness, after which limit the conditions



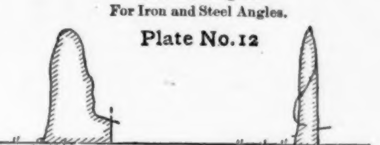
Scale of energy in ft. lbs. per inch of width of bar.
Energy Diagram per inch of width of flat steel bars.
Flat Knife.

Plate No. 11

will probably be reversed, the steel requiring the larger energy of the two materials. That the difference will be a maximum at about $\frac{1}{2}$ in. in thickness is to be supposed, as it must be remembered that the lines on the diagram of this plate representing either or both materials must terminate and meet at the zero mark.

Pressure Diagram
For Iron and Steel Angles.

Plate No. 12



6 x 6 x ¾ Iron Angle   6 x 6 x ⅝ Steel Angle
Types of Iron and Steel Cards
The violent break of steel angle is shown
by the action of ind. perc.
Scale of lbs. for ultimate press. pr. inch of width of angle

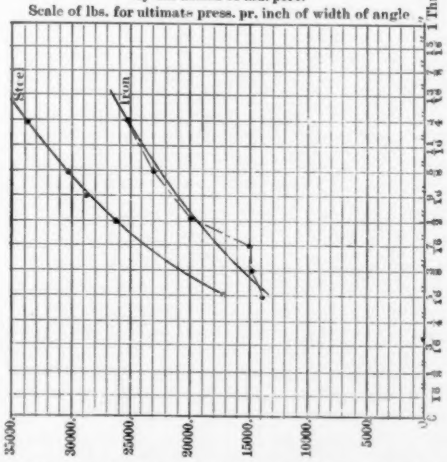
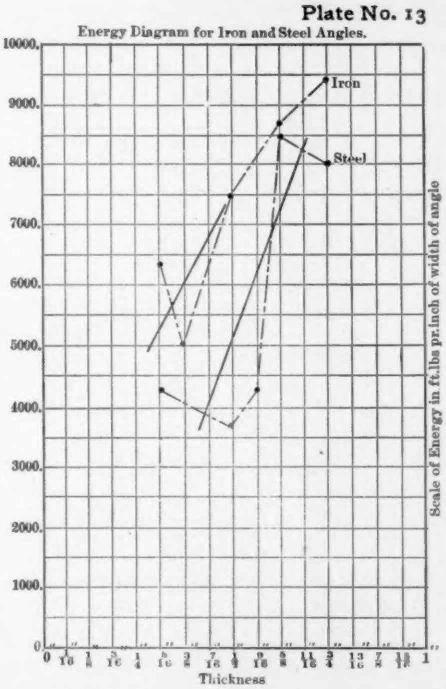


Plate No. 13

Energy Diagram for Iron and Steel Angles.



The explanation will be found by looking at the indicator cards on plate No. 12. While undoubtedly the ordinate representing the pressure is invariably larger for steel angles than for iron of the same dimensions, the shaded area representing the work done is less because of the duration of the pressure being shorter. *Steel breaks, while iron has to be cut off.* After a certain thickness has been passed the steel is not as easily broken off, thus compelling on the part of the knife a greater penetration before rupture occurs, which greater penetration and subsequent larger duration of cut suffice in combination with the more intense pressure to effect an increased energy, equal to or greater than the one corresponding to the same dimensions in iron.

HEATED STEEL.

As previously mentioned, quite diverging opinions exist with regard to the ultimate resistance of heated and rolled materials. Some years ago it was a common practice to allow 12,000 lbs. or even more per square inch as a general estimate in cutting hot work. This figure has lately been decreased to 10,000 lbs., or even 8,000 lbs, but it has been a rather rare occurrence to hear engineers argue in favor of a still smaller coefficient. Naturally the temperature and size of the piece to be cut will mainly determine its resisting qualities, although the chemical character of the steel, the percentage of carbon especially, ought as well to make its influence felt. Hitherto, in the gradual lowering of the assumed resistance per square inch, these factors have not been duly considered, but the smaller coefficients have rather been selected as based upon isolated results, now and then brought to the attention of the engineering profession.

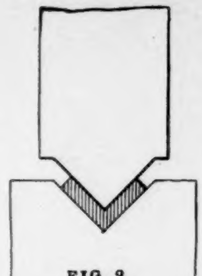


FIG. 2

As to the result of temperature, it was not within the scope of this investigation to give the decrease in strength of a bar, as it becomes heated, degree by degree. The demands of the arts, as applied to the construction of "hot shears," refer to such temperatures only which exist with the regular products as they come from the rolling-mill, and which temperatures generally vary from 1,300° to 2,000° Fahr., depending mainly on the cross-section. The intelligent and experienced workman knows at what "heat" he can roll his material to advantage, and while such temperatures are not all constant, their variation is nevertheless inside the limits already mentioned.

The knives on a hot shear are square, having neither bevel nor clearance. As the sections to be cut are generally large, no benefit would be derived from tapered blades; on the contrary, from practical reasons, such forms might be detrimental, as the increased sharpness of the edges would in all probability shorten the life of the knives.

In considering hot metal the writer has reintroduced the term, "resistance per square inch," not because he considers it eminently fitting and correct, but because of being in want of any better basis. When used in connection with the general dimensions of the bloom or billet, the resistance per square inch becomes a useful estimate.

The steel considered was:

1. Structural steel with carbon of about 20 per cent. Tensile strength in cold condition was 70,000 lbs. per square inch on 8 in. long specimen.
2. Axle steel with 30 per cent. carbon and 80,000 lbs. tensile strength when cold.
3. Spring steel with 1 per cent. carbon and a tensile strength of 130,000 lbs. per square inch when cold.

The difference in behavior between two blooms of the same cross-dimensions, one being made from structural steel and the other from axle steel, was imperceptible. Whatever be its amount, it is inside the limit of variation for any one material.

The cards from axle steel are, therefore, omitted on the plates as being unnecessary.

The spring steel, however, showed a considerable increase in resistance and energy, especially the former, as will be observed from the plates.

Plate No. 14 shows cards from a 9½ in. by 8½ in. bloom. Nos. 1 and 2 are taken from a bloom with a somewhat high temperature, resulting in a small ultimate resistance per square inch. Nos. 3 and 4 represent a lower temperature with higher resistance. No. 3 was the cut of the "crop end," this part of the bloom being naturally colder than the rest, hence its high ultimate.

The irregularities on the periphery of most cards, especially on the larger sizes, are due to the want of uniformity in action of the pumping plant, this being simply a common duplex pump without accumulator. It would appear from plate No. 14 that the resistance per square inch on a bloom of 80 sq. in., distributed to form nearly a square, is anywhere from 4,500 lbs. to 7,500 lbs., while the energy per square inch varies from 540 to 725 ft.-lbs. It must be remarked that in all tests with blooms or billets that were not square, the smaller dimension was invariably the one that was considered as depth when cutting.

Plate No. 15 shows the effects of the cooling of the bloom upon its resistance. Cards Nos. 1, 2, and 3 were all taken at different points of the two pieces, three cards on each dimen-

sion. The gradual increase in resistance, as time permitted cooling, is clearly shown.

With 36 sq. in. it appears that a square bloom offers a resistance of 9,000 lbs. to 11,000 lbs. per square inch.

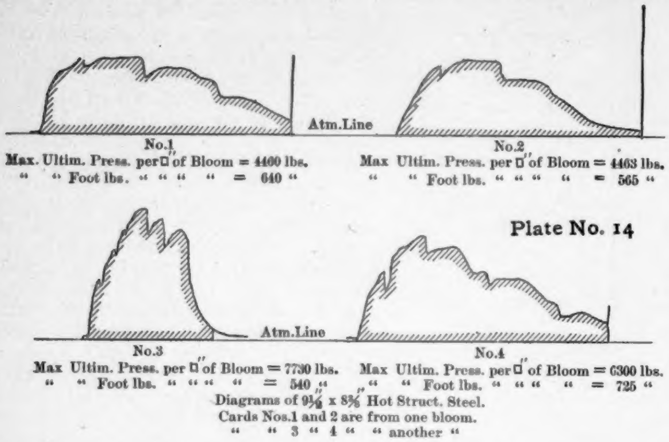


Plate No. 14

A 5 in. × 7 in. bloom, the cards of which are not shown on the plates, showed similar values.

On a 4 in. × 6½ in. billet the effect of the cooling action upon the resistance is found to exceed 100 per cent., giving figures varying from 7,200 lbs. to 15,300 lbs. per square inch.

The energy required per square inch does not seem to be much greater than what is necessary for a 6 in. × 6 in. bloom.

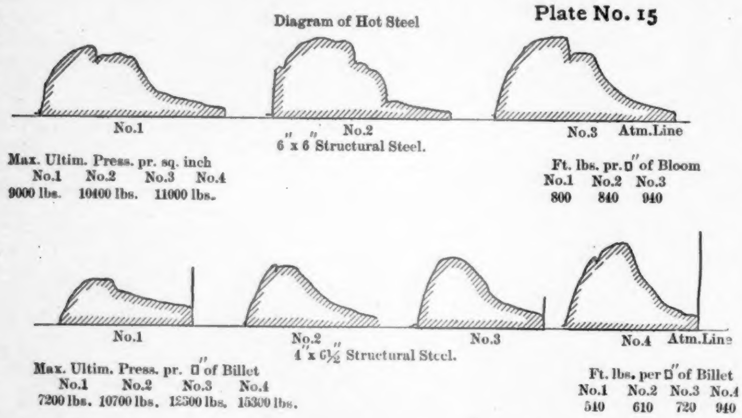


Plate No. 15

Plate No. 16 shows the difference in ultimate resistance between spring steel and structural steel to be about 25 per cent., using the maximum values in both cases. The difference in energy is very much less, being about 14 per cent.

As a general result, it will be seen *that the resistance per square inch for hot rolled steel of rectangular or square cross-sections varies from* 4,400 *lbs. to* 20,500 *lbs., depending partly upon its hardness and partly upon the size of its cross-area,* which latter element indirectly but greatly indicates the temperature, as the smaller dimensions require a considerably longer time to reduce them down to size, which time again means loss of heat.

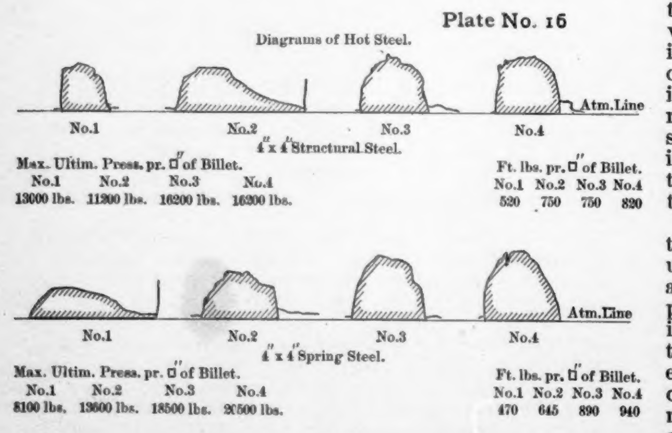


Plate No. 16

It is not probable that the resistance in practice can be brought very much below the lowest figure here given—viz., 4,400 lbs. per square inch—as a decrease of 1,000 lbs. will henceforth mean a considerable increase in cross-section and temperature.

(TO BE CONTINUED.)

THE SMOKELESS COMBUSTION OF COAL.

According to reports that have just reached us from Germany, the difficulty of burning coal without the production of smoke seems to have been completely accomplished, and the experiments leading to this result have excited a wide interest among several large industrial enterprises, including with others the North German Lloyd, the Hamburg American Packet Company, while the Vulcan Forges of Stettin have adopted this new system of smokeless combustion. This system differs from all others which have been employed for the purpose up to the present time, and it has been called "the automatic and smokeless combustion of powdered coal."

The process is an exceedingly simple one; the fuel, instead of being introduced into the fire-box in the ordinary manner, is first reduced to a powder by centrifugal pulverizers of any construction. In the place of the ordinary boiler fire-box, there is a combustion chamber in the form of a closed furnace lined with fire-brick, and provided with an injector similar in construction to those used in oil-burning furnaces. This chamber has two openings: one on the center line and in the place of the usual furnace fire-door, the other on the opposite side. The orifice of the nozzle is placed in this latter hole and throws a constant stream of the fuel into the chamber. This nozzle is so located that it scatters the powder throughout the whole space of the fire-box. When this powder is once ignited, and it is very readily done by first raising the lining to a high temperature by an open fire, the combustion continues in an intense and regular manner under the action of the current of air which carries it in. This current is regulated once for all by the amount of powder required for the production of the heat led off to the boiler and the evaporation of the weight of steam demanded.

The powder is stored in a box, whence, by means of a very ingenious arrangement, the air under pressure carries it to the fire-box. It is, in fine, a system quite analogous to those fire-boxes where boilers are fired with hydrocarbons. Numerous applications and long experience has established this latter practice on the South Eastern Railway of Russia and the steam vessels of the Caspian Sea.

In the system under consideration the coal, that it may be drawn out and carried along by the steam or air under pressure, needs to be finely pulverized, and that is why such success has been attained in the use of coal that was already finely divided.

The air and fuel are therefore intimately commingled in the zone of combustion, while the air, having served as a vehicle for carrying the powder, loses the greater portion of its velocity. It can readily be seen that in this process the combustion of the fuel is complete, for each particle of coal in suspension in the fire-box is in contact with the oxygen required for its consumption, which is thus proven to be a state of affairs far less difficult of attainment than is usually imagined. Besides, tests have thoroughly demonstrated the truth of these assertions, since no trace of smoke is perceptible.

It may also be remarked that the air entering the combustion chamber may be first heated to a high temperature by utilizing the heat of the escaping gases in the stack. This air may also be mingled with a jet of steam, which decomposes into hydrogen and oxygen, the hydrogen serving by its combustion to assist in the elevation of the fire-box temperatures. By this system the admission of cold air is entirely avoided and a constant temperature can be easily obtained, since it does not depend on the ability of the fireman. In case of accident the fire can be instantly extinguished, by giving a single turn to the valve, which cuts off the supply of fuel. The injury done by forced fires to the boilers is not to be feared, and high stacks are no longer a necessity, as the fire-box is operated under a sort of forced draft.

If we can believe the published reports of the results obtained, they seem to be little short of the marvellous. The absence of smoke should be complete, and the practical operation of the system seems to present no difficulty. Electric lighting and other companies that have plants in the center of cities will find advantages in its use, upon which we have no need to insist. Even if it were less economical than the methods in vogue, the very fact of its suppression of smoke should lead to its adoption. Another advantage is the avoidance of an accumulation of ashes, necessitating a deal of work. —*L'Electricien.*

STRENGTH OF CONCRETE.

THE paper which was read before the Society of Architects by Mr. H. W. Chubb referred to the use of concrete as a material in building fire-proof structures. The specimens of concrete which Mr. Chubb mentioned as having been tested by Mr. J. J. Webster, M.I.C.E., had been specially prepared. The following table shows their composition, together with the results which were obtained :

Nature and Proportions of Materials in Concrete Briquettes.	Average Weight per Cubic Foot.	Breaking Weight Per Square Inch at 60° F.	Breaking Weight per Square Inch after Being Heated and Quenched.	Average Loss Per Cent of Original Strength after Heating and Quenching.
	Lbs.	Lbs.	Lbs.	Per cent.
Neat Portland cement	124.6	554.6	117.2	60.8
1 part cement, 1 part sand	120.9	448.0	93.0	80.0
1 " 3 parts sand	111.2	100.8	18.7	81.4
1 " 5 " "	109.7	74.6	15.0	79.8
1 " 4 " iron furnace slag	163.08	108.1	23.06	69.3
1 part cement, 1 part pumice-stone	64.8	94.58	38.3	59.5
1 part cement, 4 parts broken fire-brick	95.04	84.4	30.5	50.9
1 part cement, 4 parts coke breeze	71.65	69.9	39.06	57.1
1 part plaster of Paris, 4 parts broken firebrick	89.6	66.8	10.3	75.0
1 part plaster of Paris, 4 parts pumice-stone	55.6	57.4	3.4	94.7
1 part plaster of Paris, 2 parts furnace slag	148 0	223.3	6.9	96 8
1 part plaster of Paris, 2 parts broken firebrick	106.9	167.5	15.7	90.0

—*The Architect.*

PNEUMATIC TUBES ABROAD.

PNEUMATIC tubes for local transmission of telegrams are now used in the principal cities of Great Britain, says the *Engineering Magazine.* At present about 50 miles of such tubes are in operation, requiring an aggregate of 400 H. P., and transmitting a daily average of 105,000 messages (or 30,000,000 annually), more than half of these in London. The lengths of tubes vary greatly ; the average length is 630 yds.; the greatest single length in London is 3,992 yds.

The tubes are of lead, laid in cast-iron pipes, for protection, and are usually of 2¼ in. inner diameter ; some tubes of 1½ and some of 3 in. inner diameter are used. As a general rule, with the same air pressure and diameter of tube, the speed varies inversely as the length of the tube. In tubes not over a mile long the usual average speed is 25 to 30 miles an hour. The carriers are of gutta percha, covered with felt, with a buffer at the front end, and an elastic band at the back or open end to hold in the messages. An ordinary carrier weighing 2¾ oz. holds a dozen messages.

The marked success of the British pneumatic service led to the adoption of similar systems in Paris, Vienna, and Berlin. The pneumatic system of Paris was put into operation in 1866, and has grown steadily, so that to-day in Paris tubes are used almost exclusively for transmission of local telegrams and letters demanding quick delivery. A small stamped envelope, the *petit bleu,* costing 50 centimes, or 10 cents, is used for the message, which, dropped into a special post box, is delivered anywhere in Paris within an hour, often in 25 minutes.

In Vienna the "tube post" was established in March, 1875. The nine districts of the city are connected with a central station. The "tube mail" is dropped into special post boxes, collected every half hour, forwarded to the central station and distributed. Pneumatic envelopes cost 15 kreuzers (about 6 cents), ordinary letters 3 kreuzers. "Tube letters" are delivered within one hour after mailing. The Vienna system consists of a main circuit of 5.34 miles, with three branch lines ; total length, 7.2 miles.

In Berlin the Prussian postal authorities began in 1862 discussion of measures of relief for the overcrowded local telegraph system, and a pneumatic line was opened in 1865 between the central telegraph station and the Exchange building. The beginning of the present extensive "tube post" of Berlin dates from 1876, since which time it has been enlarged, until there are now over 28 miles of tube line in the city, with 38 stations.

Tube letters are to-day delivered in Berlin more quickly than telegrams at a cost equivalent to 7½ cents, and "tube post cards" at 6¼ cents. The tubes in Berlin are of wrought iron and have an inner diameter of 2.55 in. The system is operated by eight steam-engines, aggregating only 128 H. P.

WEIGHTS AND DIMENSIONS OF CERTAIN FREIGHT CARS.

MR. J. KRUTTSCHNITT, General Manager of the Southern Pacific Company, Atlantic system, has collected some data regarding the comparative weights per running foot of box and gondola cars and gun trucks, which are given in the accompanying table.

WEIGHTS AND DIMENSIONS OF CERTAIN FREIGHT CARS.

RAILROAD.	Kind of Car.	Weight Empty.	Capacity.	Total Loaded Weight.	Weight per Foot of Total Length.	Weight per Foot of Total Wheel Base.	Weight per Foot of Truck Wheel Base.	Weight per Foot of Wheel Base of two Adjacent Trucks.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Pennsylvania	Hopper bottom gondola.	23,200	60,000	83,200	2,853	3,698	8,320	4,992
E. T., V. & Ga.	"	25,000	50,000	75,000	2,459	3,268	7,500	4,286
Chesapeake & Ohio	"	24,000	60,000	84,000	2,732	3,294	8,400	5,509
Phila. & Reading	"	22,800	60,000	82,800	2,343	2,885	8,572	5,018
Pennsylvania	Gun truck	36,100	80,000	116,100	3,518	4,110	....	...
Pennsylvania	Flat car	51,800	100,000	151,090	3,779	4,338	...	...
Baldwin L. Works	"	24,000	70,000	94,000	2.849	3,663	10,080	5,640
Louisville & N.	Box car.	28,000	60,000	88,000	2,400	2,983	8,653	5.074
S. Pacific	"	23,500	50,000	73,500	2,390	3,063	7,602	4,477
S. Pacific	"	27,000	50,000	77,000	2,095	2,678	7,962	4,358
Pennsylvania	"	30,000	60,000	90,000	2,400	2,849	9,000	5,622

ELECTRIC MINE RAILWAY AT BLEIBERG, IN CARINTHIA.

AT the lead mines of the Bleiberg Union, which cover a considerable extent of ground, the mineral from the different working places is brought to a main drawing shaft, the Rudolph shaft, 400 ft. deep, connected at the surface with the central dressing floor, along the adit-level in tubs containing 1,250 lbs., which, when pushed by hand for a distance of 3,000 ft., employed a force of 21 putters, making 19 journeys in the shift, in order to supply the daily output of 224 tons. The working of the dressing floor being in some danger of interruption from the disinclination of the putters to work regularly during the season of active operations, which is confined to the nine months, April to December inclusive, or 234 days, it was determined to substitute mechanical for hand traction in the adit, and, as there was 8 H. P. available at the dressing floor, it was determined to utilize it, partly for lighting and partly for hauling purposes. For the former purpose 30 incandescent and two arc lights have been provided, saving about $500 per annum upon the former cost for illumination ; while for the second an electric railway has been established in the adit.

The railway is different in many respects from those previously established in collieries and other mines with large and regular levels. Both shaft and adit are very wet, rendering special care necessary in the insulation, and the latter is crooked and so narrow that the dimensions of the locomotive

are restricted in breadth to 28 in., with a gauge of 17 in., and a height of 5 ft. 8 in. from the top of the rail to the overhead conductors. The work, which is limited by the capacity of the winding engine of the shaft, consists in drawing 40 trains of five loaded tubs in the shift of 10 hours, with a mean speed of 7½ miles per hour. The tub weighs 450 lbs., the load 1,250 lbs., and the engine 3,400 lbs., giving a total weight per train of 11,770 lbs., which, on a level line with a traction coefficient of 1 per cent., requires a mechanical effort of 2.15 H. P., the corresponding electrical energy being 2.15 × 736, or 1,600 watts, or, allowing for resistance in the conductors and eight glow lamps on the road, about 2,500 watts as the normal working current, which, however, is considerably exceeded at starting. The dynamo, of compound construction, is designed for a maximum of 6,000 watts at 700 revolutions per minute, giving a current of 220 ampères and 22 volts. The engine house is 300 ft. from the shaft; the current is conveyed to the latter by two 6-mm. copper wires, and thence down to the adit by a cable with two triply insulated wires covered with lead, which is laid in a water-proofed wooden case in the footway division of the shaft, so that it may be readily accessible. The line conductors are 6-mm. wire of silicon bronze, which are supported by insulators 13 in. apart and 5 ft. 8 in. above the rails. These insulators are roofed with sheet zinc and connected by pieces of galvanized wire rope to other bracket insulators fixed to the sides of the level. This arrangement gives a double insulation, which is of some importance, as the rock, from its numerous lodes and cross courses, has a not inconsiderable conductivity. In order to divert the current at points of junction the insulated line carriers are mounted on a sliding frame, so that they can be shifted laterally from one to the other line. These points are marked by incandescent lights.

The locomotive, which is about 8 ft. total length, has two axles, 3 ft. 3 in. apart, carries a motor with a Hefner-Alteneck armature and 46-part commutator, making the same number of revolutions—700—as the primary dynamo, which is reduced by a screw and worm-wheel to 88 revolutions on the driving shaft, and to 34 revolutions on the front driving axle, by chain gearing, in order to obtain the required speed of 7½ miles per hour. The driving axle is coupled to the hinder one by a similar chain, the total adhesion weight of the engine being required for the full train of five vehicles. When only the front axle is driving, the load must be reduced to three.

The current is taken and returned by a pair of curved tubular arms, forming spring poles, with insulated iron plates at their ends upon spring carriers, which

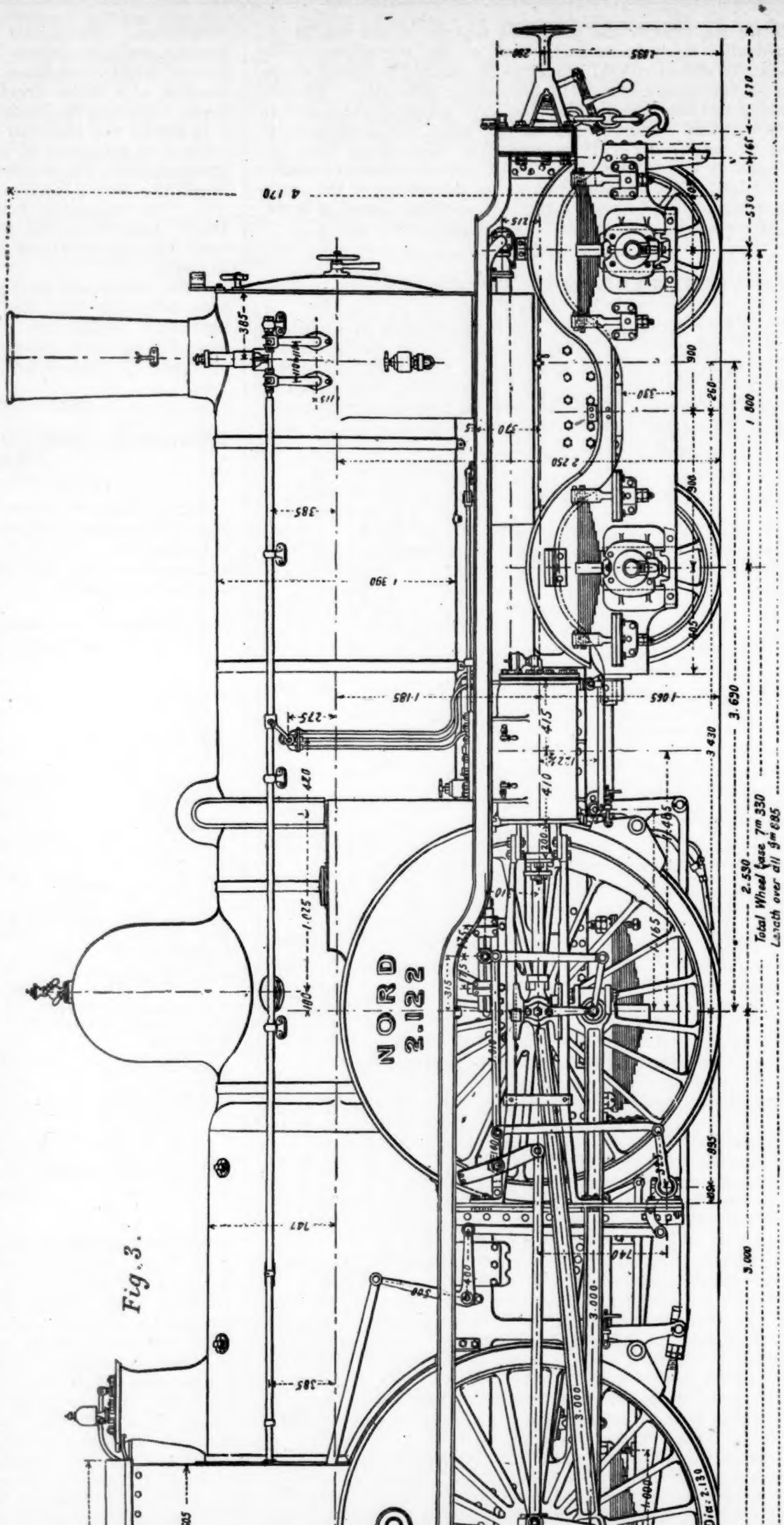


Fig. 3.

COMPOUND EXPRESS PASSENGER LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

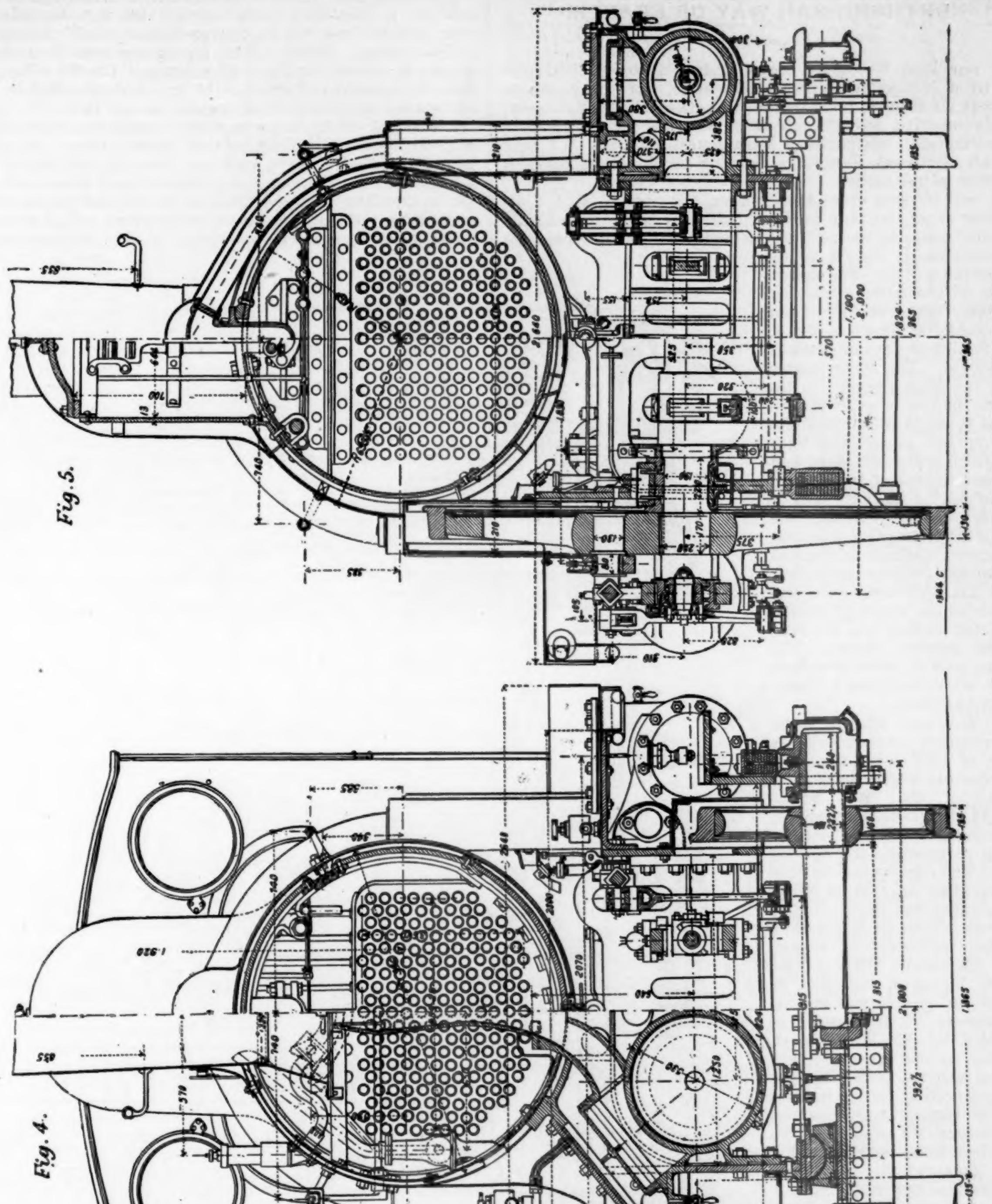


Fig. 5. Fig. 4.

COMPOUND EXPRESS PASSENGER LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

maintain a sliding contact with the line wires. The latter have been made of silicon bronze, in preference to copper, in order to resist abrasion by the rubbing of the contact plates.

The results of the trials show the insulation to be very perfect, the loss of tension being less than was expected. The total current used, as measured at the generating dynamo, varied between 8 and 16 ampères, the meter rising to 35 ampères at the moment of starting, while in smooth running it oscillates between 8 and 12 ampères. The average energy required for working the line and the lighting of the road and the engine, including all losses in the conductor and magnetic friction, is $220 \times 10 = 2{,}200$ volt ampères, or 3 H. P., and, as the motor does 2.15 H. P. work, the efficiency is 70 per cent.

The installation, costing \$6,500, does the work of 21 putters in the level, their place being now taken by 16 fillers, at lower wages, the total saving being given at from \$1,750 to \$2,000 per annum. The advantage of lighting up the crossing points of the branch levels and the shaft bottom, which is done by pairs of 16-candle glow lamps, is also found to be of great advantage to the miners.—*Proc. Inst. C. E.*

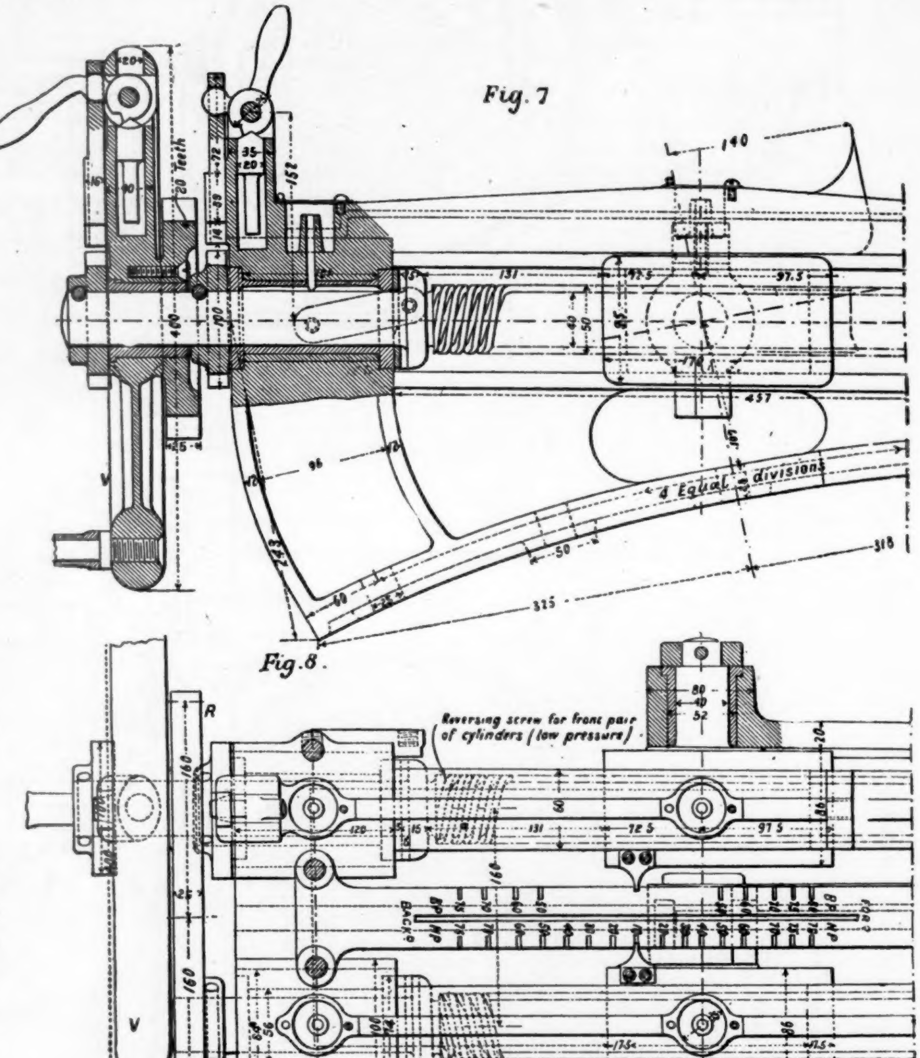
COMPOUND EXPRESS LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

In our issue for March we published a longitudinal section of a compound express locomotive, for the Northern Railway of France, built to the designs of M. Du Bousquet, the Locomotive Superintendent of the line by the Société Alsacienne de Constructions Mécaniques, Belfort. We now publish additional engravings showing the details of the construction of the engine.

As will be seen from these views, the engine is of four-cylinder type, the high-pressure cylinders being placed outside the frames in the rear of the bogie, and the low-pressure cylinders inside the frame under the smoke-box. The steam-chests of the latter cylinders, however, are accessible from the outside, as shown in fig. 4, thus facilitating examination of the valves. The steam passes from the high-pressure cylinders to the low-pressure steam-chests through an intermediate receiver cast in one piece with the low-pressure cylinders, and common to both of them.

The engine has two pairs of coupled driving-wheels; the axle of the front pairs, which is, of course, cranked, is worked by the low-pressure cylinders, while the high-pressure cylinders drive the rear axle (which is placed behind the fire-box) by the outside cranks. The leading pair of driver-wheels is fitted with Gresham's steam sanding apparatus.

To facilitate starting, the high-pressure crank makes an angle of 162° with the low-pressure one on the same side, instead of the 180°, which would be the preferable position if the balancing of the reciprocating parts was alone considered. The consequence of this arrangement is, that in whatever position the engine stops, the port of one or the other of the four cylinders is always open for steam. This device is not, however, sufficient to insure the engine starting in all positions, as when steam is admitted into the low-pressure receiver by the valve supplied for this purpose, the back pressure produced at the same time on the high-pressure pistons may reduce the effective starting effort below what is requisite. To avoid this the three way valves, shown by figs. 9 to 12 of our engravings, have been fitted on the exhaust passages of the high-pressure cylinders. By means of these the high-pressure exhaust may be turned direct up the blast-pipe when desired. The joint between the high-pressure exhaust-pipe and each of the valves just mentioned is made by a stuffing-box having metallic packing, as shown in the engravings. This plan has been adopted with a view to lessening expansion strains. As will be seen from the views, figs. 9 and 11, the three-way valve (which is of cast iron) rotates in a cylindrical casing having three branches communicating with it, that on the left, in fig. 11, being the exhaust from the high-pressure cylinder, while that on the top communicates with the exhaust-pipe in the smoke-box. The valve is connected to a spindle which passes through a stuffing-box fitted with metallic packing, the spindles of the two valves in the opposite sides of the engine being connected by levers to the piston of a small auxiliary steam cylinder placed under the boiler, as shown in the longitudinal section of the engraving published in March.



COMPOUND LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

The admission of steam to and its release from this auxiliary cylinder is controlled by two cocks, shown in the side elevation, and the three-way valves can be thus readily manipulated by the driver. By the aid of the arrangement described the engine is enabled to exert at starting a tractive effort of 10 tons, the pressure of steam is in intermediate receiver, being at the time maintained at 85 lbs. per square inch.

The engine is, by the arrangement above described, capable of being worked in four different ways—viz.: 1. As a compound locomotive, as in ordinary running. 2. As two independent engines, one set being worked with steam at 200 lbs. per square inch and the other at 85 lbs. per square inch, as in starting. 3. With the two high pressure cylinders only, in the event of an accident happening to the low-pressure gear. 4. With the low-pressure ones only in the event of the high-pressure portion of the engine being disabled.

The boiler is designed for a pressure of 200 lbs. per square inch, and is intended to give an ample supply of steam. The fire-box of one of the engines built of this type is fitted with a Tenbrinck water bridge, as shown in the longitudinal section, while that of the second engine is provided with the usual fire-brick arch. The fire-box heating surface, exclusive of the water bridge, is 148.5 sq. ft. The barrel of the boiler is telescopic, the smallest belt being to the rear, over the low-pressure cranks, where as much room as possible is required. The dome is placed on this belt. The two safety-valves, which are of the Ramsbottom type, are placed over the fire-box. The plating of the boiler, which is of iron, is 18 mm. (0.71 in.) thick.

The valve-gear is of the Walscheart type, and can be operated independently for the two sets of cylinders. The reversing-gear, which is shown in detail by figs. 7 and 8, consists of two screw-gears placed side by side; one of these—namely, that for the low-pressure cylinders, carries the hand-wheel *V*. Firmly fixed to this hand-wheel is a pinion *R*, gearing with the second pinion *R* on the high-pressure reversing screw. The hand-wheel, however, is not keyed on its spindle, but can be fixed to it solidly when required by a catch, in which case it operates both gears when turned. On raising the catch it runs loose on its spindle, and drives the high-pressure gear only by means of the pair of pinions already mentioned. The side valves of the high-pressure cylinders were originally made with an inside clearance of 1.5 mm. (0.06 in.), with a view of reducing compression; but since indicator diagrams have been taken from the engine in actual work, it has been decided to double this amount of clearance.

The general arrangement of the engine framing will be readily seen from our engravings. The frame-plates, which are of iron, are 28 mm. (1.1 in.) thick, and, in addition to being connected in the usual way of leading trailing ends, and by the low-pressure cylinders, they are firmly braced by a steel casting inserted between the points of attachment of the high-pressure cylinders, as shown by the engraving published in March, and by the right-hand halves of the transverse section, published in this issue. The casting, which is .68 mm. (26.8 in.) long, serves to support the ends of the low-pressure crosshead guides, and also the valve links.

Fig. 9.

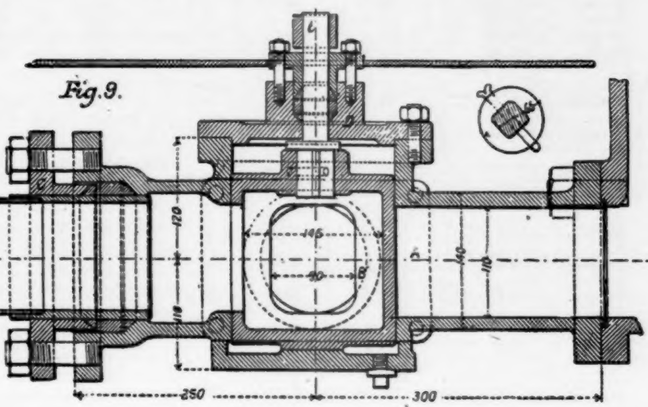


Fig. 10.

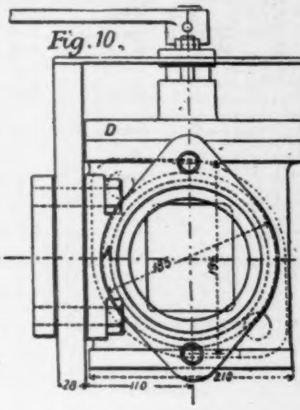


Fig. 11.

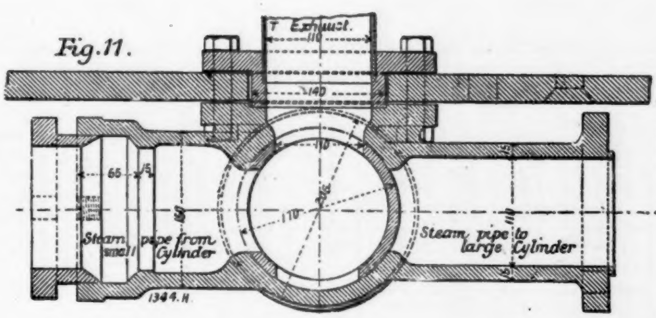
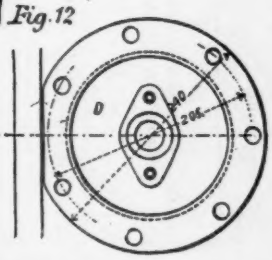


Fig. 12



COMPOUND LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

The bogie, as will be seen by our engravings, has outside frames, and is not arranged for lateral displacement. The cranked axle is of the Worsdell type, with circular crank cheeks. The engine is fitted up with a vacuum-brake worked by two injectors fixed to the smoke-box. All the driving-wheels are fitted with brake-blocks, these being operated by two brake cylinders of the Hardy type, fitted to the front part of the tender. The driver's platform is well protected by a hood, and is lighted at night by a lamp in the roof. The general appearance of the engine is well shown in fig. 3.

The tender has six wheels, and can hold 14 tons of water and 4 tons of coal. It is provided with vacuum-brakes acting on all six wheels. The connection between the engine and the tender is made by a rigid coupling-link and two buffers fitted with spiral springs. The principal dimensions of the engine and tender are as follows:

Length of fire-box	2.013 m.	6.604 ft.
Breadth of fire-box	1.012 m.	3.320 ft.
Grate area	2.04 sq. m.	21.96 sq. ft.
Height of fire-box in front	1.725 m.	5.659 ft.
Height of fire-box at back	1.475 m.	4.839 ft.
Mean diameter of boiler	1.26 m.	4.134 ft.
Thickness of plates	.018 m.	.708 in.
Height of center line above rails	2.242 m.	7.349 ft.
Tubes, number		202
" external diameter	.045 m.	1.77 in.
" thickness	.0025 m.	.098 m.
" length between tube plates	3.9 m.	12.78 ft.*
Heating surface of fire-box	10.87 m.	117 sq. ft.
" " " water bridge	2.70 m.	29.06 ft.
Heating surface of tubes	98.98 m.	1065.44 ft.
Working pressure	14 kg.	200 lbs. per sq. in
Maximum pressure in low-pressure receiver	6 kg.	85.34 " " "
Width between frames	1.25 m.	4.101 ft.
Thickness of frames	.028 m.	1.102 in.
Diameter of bogie wheels	1.04 m.	3.412 ft.
" " driving-wheels	2.114 m.	6.935 ft.
Total wheel base	7.330 m.	24.05 ft.
Diameter of high-pressure cylinders	.340 m.	13 39 in.
Distance apart from center to center	2.070 m.	6.792 ft.
Stroke	.640 m.	25.2 in.
Diameter of low-pressure cylinders	.530 m.	20.87 in.
Distance apart from center to center	.570 m.	22.45 in.
Stroke	.640 m.	25.2 in.
Ratio of volumes of cylinders		2.42.
Ratio of receiver to volume of both high-pressure cylinders		1.36.

	High Pressure.		Low Pressure.	
Lap of valves, outside	.054 m.	2.13 in.	.054 m.	2.13 in.
Clearance of valves, inside	.003 m.	.12 in.	.003 m.	.12 in.
Maximum tractive power working compound			7,847 kg.	7.723 tons.
Maximum traction at starting			10,000 kg.	9.842 tons.
Average tractive power in practice, working compound			5,070 kg.	4.99
Weight of engine, empty				43.80 tons.
Weight of engine in working order				47.80 tons.
Weight on bogie				17,30 tons.
" " leading drivers				15.35 tons.
" " trailing				15.15 tons.

TENDERS.

Diameter of tender wheels	1.2475 m.	4.093 ft.
Capacity, water		14.16 tons.
" coal		4.0 tons.
Weight of tender, empty		15 tons.
Total wheel base of engine and tender coupled	13 36 m.	43.83 ft.
Length over buffers	16.44 m.	53.94 ft.

We now give details of the very complete set of tests which have been made with this locomotive. From experiments it appears that these engines get up speed very vuickly, and will easily take up a continuous gradient of 1 in 200 and 12½ miles long, either a train of 140 tons weight, exclusive of engine and tender, at a speed of 53 miles an hour, or one of 200 tons at a speed of 46½ miles per hour. The first train did the distance from Paris to Amiens (81¼ miles) in 1 hour 30 minutes. The second took two hours to go from Paris to St. Quentin, a distance of 95¼ miles. In both cases the speed varied very little with

TABLE I.—TIMES, SPEEDS, AND WEIGHTS OF TRAINS.

—	Train.	—	Depart.	—	Arrive.	Distance.	Speeds, Miles per Hour.					Load Tons.
							Paris Creil.	Creil Amiens.	—	—	—	
1st day. ...	15 bis	Paris.......	11.40 a.m.	Amiens	1.23 p.m.	81.2	49.7	50.3	.. ..	....	....	110 to 150
	0 "	Amiens ...	5.27 p.m.	Paris.......	7.10 "	81.2	52.8	51.0	....	... .	....	110
2d "	B	Paris	10.10 a.m.	Amiens	11.56 "	81.2	47.2	49.7	....	....	....	100
	30	Amiens	3.7 p.m.	Paris.......	5.25 "	81.2	42.9	44.7	....	....	....	140
								Creil Tergnier	Tergnier Busigny	Busigny Aulnoye	Aulnoye Mons	
3d "	5 bis	Paris..	8.15 a.m.	Mons.......	12.49 "	154.8	44.1	47.8	41.6	47.2	34.8	175
	48	Mons.......	7.36 p.m.	Paris.......	11.33 "	154.8	44.1	44.7	46.0	49.1	41.0	160
4th "	33 bis	Paris.......	6 20 "	Mons.......	10.46 "	154.8	46.0	47.2	42.9	47.8	37 3	145
5th "	16 "	Mons.... ..	8.36 a.m.	Paris... ...	12.33 "	154.8	42.3	47.2	45.4	46.0	37.9	115
							Paris Creil	Creil Amiens				
6th "	15	Paris	11.30 "	Amiens ...	1.13 "	81.2	49.7	50.3	....	. ...	....	110 to 150
	O	Amiens.....	3.58 p.m.	Paris.......	5.47 "	81.2	49.7	47.8]	....	... .	....	100
									Amiens Arras	Arras Douai	Douai Lille	
7th "	11	Paris......	8.0 a.m.	Lille........	11.58 "	156.0	42.9	46.0	48.5	49.7	38.5	120 to 170
	46	Lille........	7.25 p.m.	Paris.......	11.7 "	156.0	47.2	49.1	49.7	49.7	44.1	120 to 150
8th "	C_1	Paris.......	3.15 "	Amiens	5.5 "	81.2	46.6	46.0	... .	....	....	145
"	C_2	Amiens ...	9.4 p.m.	Paris.......	10.47 "	81.2	52.8	51.0	....	....	....	145 to 200
9th "	17 bis	Paris.......	12.55 "	Amiens	3.17 "	81.2	39.1	46.0	....	....	... .	145
"	O	Amiens	5.17 "	Paris.......	7.0 "	81.2	52.8	51.0	... .	....	....	110
10th "			(not running)									
	Total distance run in ten days =..........					1743.2						
	Average per day........					174.32						

profile of the line. On page 190 we show copies of 15 sets of diagrams chosen from a number taken during the trials made on March 17 and 22, 1892. They show the steam distribution in very varied conditions of working. Table II., below, shows the pull on the tender drawbar, and the results of an analysis of the diagrams with particular reference ticularly noticeable in Diagrams 6 and 15, which, taken at high speeds, show a lower fall of pressure than is usual with locomotives in such conditions. Diagrams 9 and 10, taken with a cut-off of 45 per cent. in the low-pressure cylinders, correspond to the least fall of pressure in the intermediate receiver. The greater falls of pressure which a longer cut-off

TABLE II.—RESULTS OBTAINED FROM TRIALS OF COMPOUND LOCOMOTIVES ON NORTHERN RAILWAY OF FRANCE.

Number of Diagram.	Distance Run.	Profile of Line.	Pressure.		Cut-Off per Cent.		Speed in Miles per Hour.	Pull on Drawbar of Tender.	Work being Done on Drawbar.	Work Due to Acceleration of Engine and Tender.	Total Work being Utilized on Drawbar, taking Acceleration into Account.	Indicated Horse-Power.			Efficiency of Mechanism $\mu = \frac{Tl\,u}{T\,m}$
			In Boiler.	In Intermediate Receiver.	High-Pressure Cylinders.	Low-Pressure Cylinders.						High-Pressure Cylinders.	Low-Pressure Cylinders.	Total T m.	
		Slope per cent.	Lb. per sq. inch.	Lb. per sq. inch.				Tons.	Tu.	T.	Tl u + T.				Per cent.
Train 17 bis from Paris to Longeaux. March 17, 1892. Load drawn, 175.7 tons.															
1	0	....	199.1	60.5	40	50									
2	5.51	3.5 up	199.1	64.0	42	51	47.0	1.525	427.2	— 4.24	422.96	430.0	487.0	917.0	46.1
3	46.6	4.0 "	199.1	64.0	48	55	48.5	1.772	512.6	+ 9.66	522.26	474.1	539.0	1013.1	51.6
4	51 0	3.4 "	199.1	64.0	48	55	44.2	1.967	518.5	+ 11.96	530.46	358.5	537.0	895.5	59.2
5	52.8	3 0 "	199.1	64.0	44	53	47.9	1.673	478.0	+ 16 91	494.91	474.4	497.4	971.8	50.9
6	63.5	3.5 down	192.0	49.8	34	53	61.8	.689	258.1	0	258.10	433.9	432.0	865.9	29.0
Train 17 bis from Paris to Longeaux. March 22, 1892. Load drawn, 143.7 tons.															
7	12.4	level to 3 p. c.	199.1	71.1	45	53	47.2	1.673	472.1	+ 43.1	515.7	471.7	590.0	1061.7	48.5
8	14.9	from 1 to 45	199.1	85.4	50	50	44.7	1.821	486.7	— 19.9	466.8	442.1	597.9	1040.0	44.9
9	33.5	2.4 p.c. curve of 3,250 ft.	199.1	60.5	35	45	41.6	1.427	355.0	+ 12.6	367.6	256.6	329.5	586.1	62.7
10	34 8	2.4 up	199.1	60.5	35	45	42.3	1.378	347.9	+ 5.0	352.9	293.1	334.4	627.5	56.2
11	43.8	4 "	199.1	60.5	40	51	44.7	1.614	431.4	0	431.4	368.1	408.0	776.1	55.5
12	46 5	4 "	199.1	60.5	40	51	46.0	1.575	432-5	0	432.5	346.4	386.8	732.2	58.9
13	48.5	4 "	199.1	60.5	40	51	45.7	1.526	416.3	0	416.3	435.3	469.5	904.8	44.2
14	53.0	3 "	199.1	67.6	40	48	43.5	1.526	396.4	+ 33.3	429.7	349.2	394.0	743.2	57.8
15	63.5	3.5 down.	195 5	42.7	31	51	57.2	.719	245 4	0	245.4	273.9	280.4	554.3	44.2

to the total indicated work, and its division between the two sets of cylinders.

The diagrams were taken by a Deprez and Garnier indicator, which gives the curve by points, indicating exactly the pressure of the steam corresponding to definite positions of the piston. An exception should be made for Diagram 1, which was taken as the engine started, and hence at a very slow speed, and which shows a very good steam distribution. The collection, taken as a whole, shows that the steam pressure is well maintained during the period of admission. This is particularly noticeable gives result in a small loss of work, but it is preferable to admit this loss rather than the much greater one which arises from excessive compression in the high-pressure cylinders, and causing, also, trouble in the running of the engine at high speeds. In this connection it should be noted that the excessive compression in the high-pressure cylinders, visible in some of the diagrams, is partly due to the fact that in these instances the back pressure has been steadily rising during the exhaust.

The dynamometer with which the pull on the drawbar was

ascertained was carefully calibrated before the trials, and its indications can be relied on. The figures obtained show that the horse power at times exceeded 1,000, a result which has been obtained on all the trials without forcing the engine in any way, the water-level and pressure being maintained at their normal value; nor was any special fuel used. It will also be noted that the power is pretty evenly divided between the two sets of cylinders. Of course, as the driving axles are coupled together, there is no advantage in this so far as adhesion is concerned; but the maximum stresses on the separate parts are thereby reduced. As regards the efficiency of the mechanism, it will be noted that the pull on the drawbar has been corrected for the acceleration of the engine and tender. This is necessary, as, when the speed is increasing, the work done in imparting a higher velocity to the engine and tender would otherwise be available at the drawbar, and similarly, when the speed is decreasing, the work already stored in the engine and tender increases the pull on the drawbar.

To form a fair idea of the capabilities of the engine, such trials as the above are insufficient, for in them the engine for obvious reasons is run under as favorable conditions as possible, and hence it is necessary to ascertain what the engine can do under ordinary working conditions. During the months of February, March, and April, the engines 2121, 2122 have worked the express service (first series) from the La Chapelle station according to the speed schedule (Table I.).

In deducing the average speeds in the above schedule, the following allowances are deducted from the total time, as well as the stops: 1 minute for starting, 30 seconds for stopping, and 1 minute for each slowing at junctions, swing bridges, etc. In the above cases the engine-drivers have frequently used the great power of their engines in making up wholly, or in part, time lost at starting, or through slows or stops on the journey.

Very good results were got on the 0.8 per cent. grade shown in fig. 13, with train O of November 6, 1891. The train had 27 axles and weighed 140 tons, excluding the engine and tender. The time made was as follows:

	h.	m.
Calais Ville, departure........	2	59
Caffiers "	3	14

Hence the distance was run in 15 minutes, including the time lost by slowing at the junction shown. The speed up the 0.8 per cent. grade was about 43.5 miles per hour. Good results have also been obtained on less heavy but longer inclines, such as that shown in fig. 14. The maximum grade on this line is 0.5 per cent. The train load was 110 tons, and it will be seen from the diagram that the speed line is nearly straight, being but little affected by the inclines.

Comparing the two new engines with two older ones—viz., Nos. 2876 and 2887, which work on the same service, the returns for the months of February, March, and April show the following results:

Numbers of Engines.	Fuel. Pounds per Mile.			Oil.
	Briquettes.	Coal.	Total.	Ounces per Mile.
2121, 2122	5.055	26.962	32.017	.880
2876, 2887	6 811	30.616	37.427	.982

The coal used in these express engines consists of the following mixture:

	Per cent.
Run of mine, 25 per cent. bituminous........	50
Small bituminous coal...	20
Small steam coal..........................	30

The figures above show, as will be seen, a saving of 14.45 per cent. with the new engines. It should, however, be noted that the total consumption as given above includes in each case the constant quantities required for lighting up and maintaining the fires at the station. To eliminate these constants, the value of which would be difficult to determine, and which are far from negligeable, trials were made of the water used by engine 2121 and engine 2863, this latter being a simple engine, with cylinders 18.11 in. in diameter, the working pressure being 156.4 lbs. per square inch. The engine was in very good condition. These engines were put to draw the same

Fig. 14.

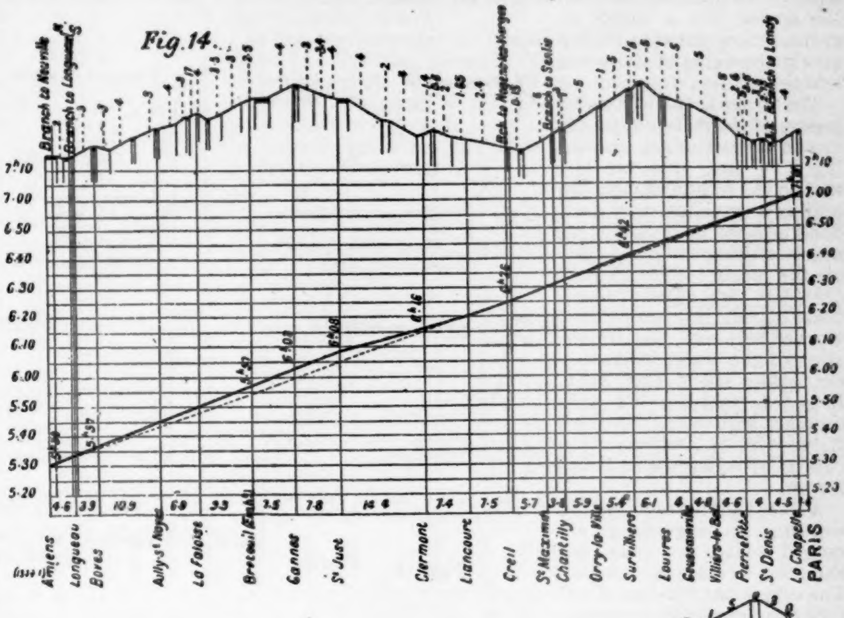


Fig. 13.

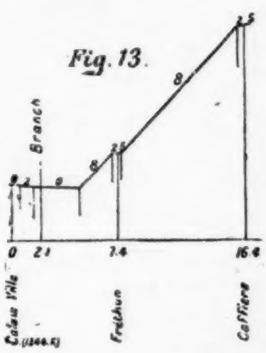
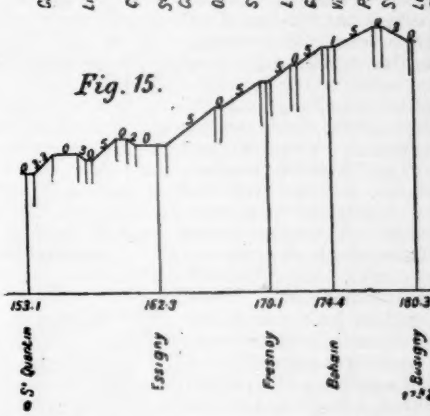


Fig. 15.



load—viz., 180 tons, at similar speeds and under identical atmospherical conditions.

The consumption, as determined on the run from Paris to St. Quentin, 95.3 miles, was as follows:

	Gallons of Water per Mile.
Engine 2893...........................	26.86
" 2121...........................	20.61

showing an economy for the latter of 23.28 per cent.

It also appears that the oil consumption of the compound was comparable to that of simple engines. The amount used was divided up as follows:

	Ounce per Mile.
14 axle-boxes (engine and tender)...........	.341
Running gear..............................	.198
Cylinders and slide-valves.................	.341
Total........................	.880

The different parts are very accessible for oiling, all important parts being easily got at. Automatic lubricators are used for the cylinders and slide-valves, and the other arrangements are so effective that runs of 155 miles can be made without requiring more than a five minutes' stop for oiling up in the course of the run.

In accordance with the usual practice of the company, the fire is started with briquettes or large coal, being afterward maintained exclusively with coal of the composition given above. The fire-boxes of these engines, being deeper at the

back than those of the "Outrance" type previously built, have some advantages. When the draft is strong the coal is not carried forward, and at the end of a run, when the grate is already covered with a certain thickness of cinders and clinkers, a sufficient thickness of bright fire can still be obtained. When first put to work both engines had Tenbrinck water bridges. In consequence of leakage, this bridge on one engine was dismounted and repaired. Since then it was worked quite satisfactorily. That of engine 2121 has, however, been replaced by a firebrick bridge, and the change seems to have made no difference in the steaming qualities of the engine, but a longer experience is required to fix definitely the value of the water bridge.

The boiler is fed by two injectors of the Sellers type, the one on the left-hand side being a 7½ mm. injector, and that on the right a 9½ mm. In ordinary running the left-hand injector is kept at work nearly continuously. In spite of the high boiler pressure (200 lbs. per square inch), both these injectors have worked very well, the temperature of the water in the tender being about 122° Fahr. It is true that the lift only becomes high—viz., from 2.6 ft. to 4.26 ft., when only 2 cub. m. of water remain in the tender.

All the handles required for working the engines are arranged so as to make the handling as easy as possible. The driver has close to hand the regulator, the reversing gear, the handle regulating the exhaust from the high-pressure cylinders, that admitting steam direct to the low-pressure cylinders, and that of the Gresham sanding apparatus, together with the valves regulating the vacuum-brake. The stoker on his side finds the whistle-gear, the damper-gear, the blow-off cocks, and the blower. When the engines had run 37,000 miles, the whole of the running gear was carefully examined and found in perfect condition, a fact which shows that the cost of maintenance will be low.

In conclusion, it may be of interest to say a word on the use of coupled wheels, the plan of giving the high-pressure cylinders an alternative exhaust up the blast-pipe, and the system of independent cut-offs in the two sets of cylinders. The coupling-rods were removed from engine 2121 for some days in March, 1892, and during that time it ran, on March 3, the trains C_1, weighing 145 tons, and C_3, with 170 tons. The rail was in very good condition, but slipping occurred at every start and even sometimes on the inclines. Down grade the speed was the same as with the rods in place. In short, under these very favorable conditions no advantage was found in the running of the engine, while, on the other hand, the starting power was reduced, and, moreover, the vibration at high speeds was considerably increased, due to the fact that the relative position of the cranks was no longer maintained.

As regards the plan of providing an alternative escape up the blast-pipe for the high-pressure cylinders, this arrangement increases the starting power, the tractive effort being then capable of reaching 10 tons. It should, however, be noted that to utilize this great tractive power a coefficient of adhesion of $\frac{1}{3.5}$ would be required, which is difficult to obtain even with the Gresham sanding apparatus. By means of the special regulator with which these engines are provided, it is, however, possible to work the engines at starting at very nearly their limit of adhesion. Further, the arrangement in question has this further advantage, that, in case of breakdown, either set of cylinders can be worked independently of the other. Thus, with train 17 bis of December, 1891, the front cylinder cover of one of the low-pressure cylinders of engine 2121 broke at kilometer 70 between Clermont and St. Just, but the driver took the train on to Amiens (kilometer 131) with the high-pressure cylinders only. This run of 61 kilometers (38 miles), 10½ of which were up a 0.4 per cent. grade, was done in one hour; the average running speed was 46 miles per hour, the load being 150 tons. If necessary, the engine could have taken the train beyond Amiens.

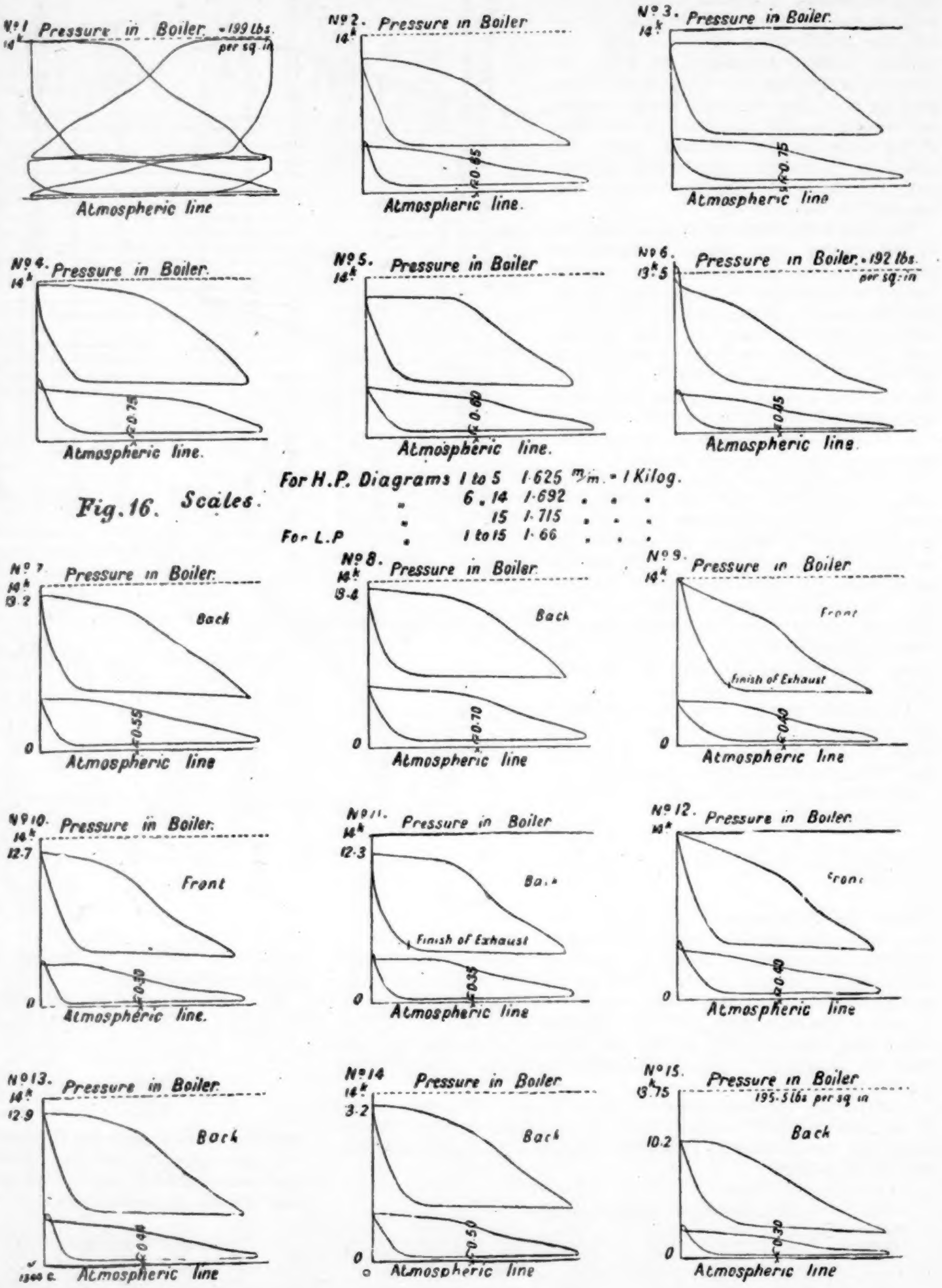


Fig. 16.

A compound engine previously built by the company—viz., No. 701, did not run down grade as well as the simple engines, but the new engines, when working compound, have attained speeds of 62 to 75 miles per hour under these condi-

tions. This easy running is partly due to the large size of the various steam-pipes, but also to the independence of the two sets of expansion gears. Experience has shown that, owing to this, the pressure in the intermediate receiver can be lowered by giving a late cut-off to the low-pressure cylinders, which facilitates the running of the engine at high speeds. The following trials were made with trains 17 bis of December 5 and 7, 1891, weighing 140 tons. On the first occasion the cut-off was made the same in the two cylinders up to kilometer 111, and then changed. On the second occasion the reverse was the case.

Date.	Load.	Regulator.	Position on Line.	Admission Per Cent. High-Pressure.	Admission Per Cent. Low-Pressure.	Pressure. Boiler.	Pressure. Intermediate Receiver.	Speed. Miles per Hour.
	Tons.		Kilom.			Lb. per sq. in.	Lb. per sq. in.	
Dec. 5	140	Half open	100 to 111	40	40	185	56.9	57.2
			116 to 117	30	50	185	35.6	62.1
			118	..	..	192	39.1	64.0
Dec. 7	140	Half open	108 to 112	35	50	192	42.7	62 1
			116	40	40	199	78.2	55.9

This independence of the expansion gears also facilitates the running of the engine with one set of cylinders in case of a breakdown.

We are indebted to *Engineering* for both the description and engravings of this engine.

THE SYSTEM OF ELECTRIC CAR LIGHTING ON THE JURA-SIMPLON RAILWAY.

After many experiments the Jura Simplon Railway have adopted two types of lamps for use in their electric system of lighting, to wit: Lamps of 10 candle power for lighting the interior, and lamps of 5 candle power for lighting platforms and toilet-rooms. The lamps of 10 candle power are of the oblong form, those of 5 are round; they are all attached to the ceiling of the car inside of a hemispherical glass globe, such as is used for gas lighting. Fig. 1 gives a sectional view of a lantern, and shows how the incandescent lamp is attached. The heat developed by the lamp causes very rapid deterioration; they have therefore been placed under the ventilators, so that they are continually cooled by the ascending current of fresh air.

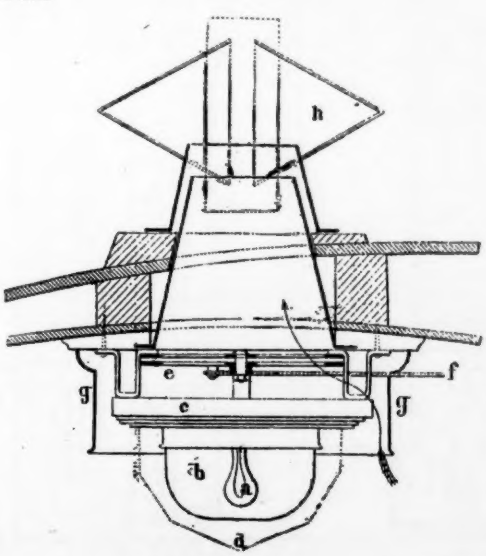


Fig. 1.

Above the lamp there is a convex reflector, which diffuses the light below it better than can be done by one of concave form. The accumulators are placed in a box beneath the floor of the car. This box is closed by a shutter which turns up vertically, and is composed of two smooth pieces of wood furnished with contact plates, which are soldered to the ends of the main wire which feeds the lamp in the car. When the tray containing the accumulators is put into this box, the two bars attached to the poles of the battery come in contact with the two strips of wood, so that the connections are automatically made. Fig. 2 gives a perspective view of a battery and accumulators in the sliding drawer. The lighting and extinction of the lamps are done by means of a switch on the main wire that is fastened to the outside of the car near the brake van. This switch can only be moved by means of a special key, which is carried by the trainmen. In each first-class compartment there is a special cut-off identical with the main cut-off and led into a branch wire from the lamp.

This cut-off permits the lamp to be put out when the apartment is unoccupied.

At first the passenger had facilities for regulating the intensity of the light for himself. This was done by placing two lamps of 5 candle power each in each compartment instead of one of 10. A special switch permitted the two lamps to be put in series, which gave faint light, or in parallel, which gave the normal light; but the trials were unsatisfactory and the method was abandoned.

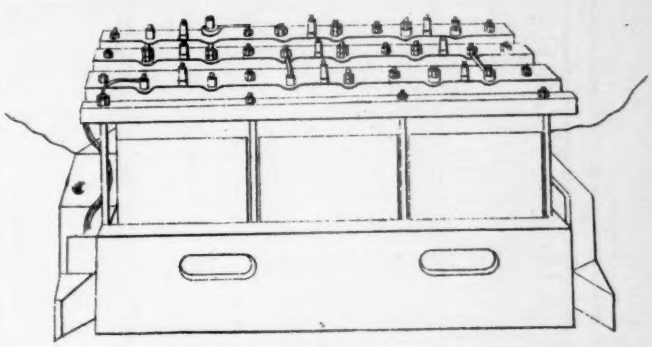


Fig. 2.

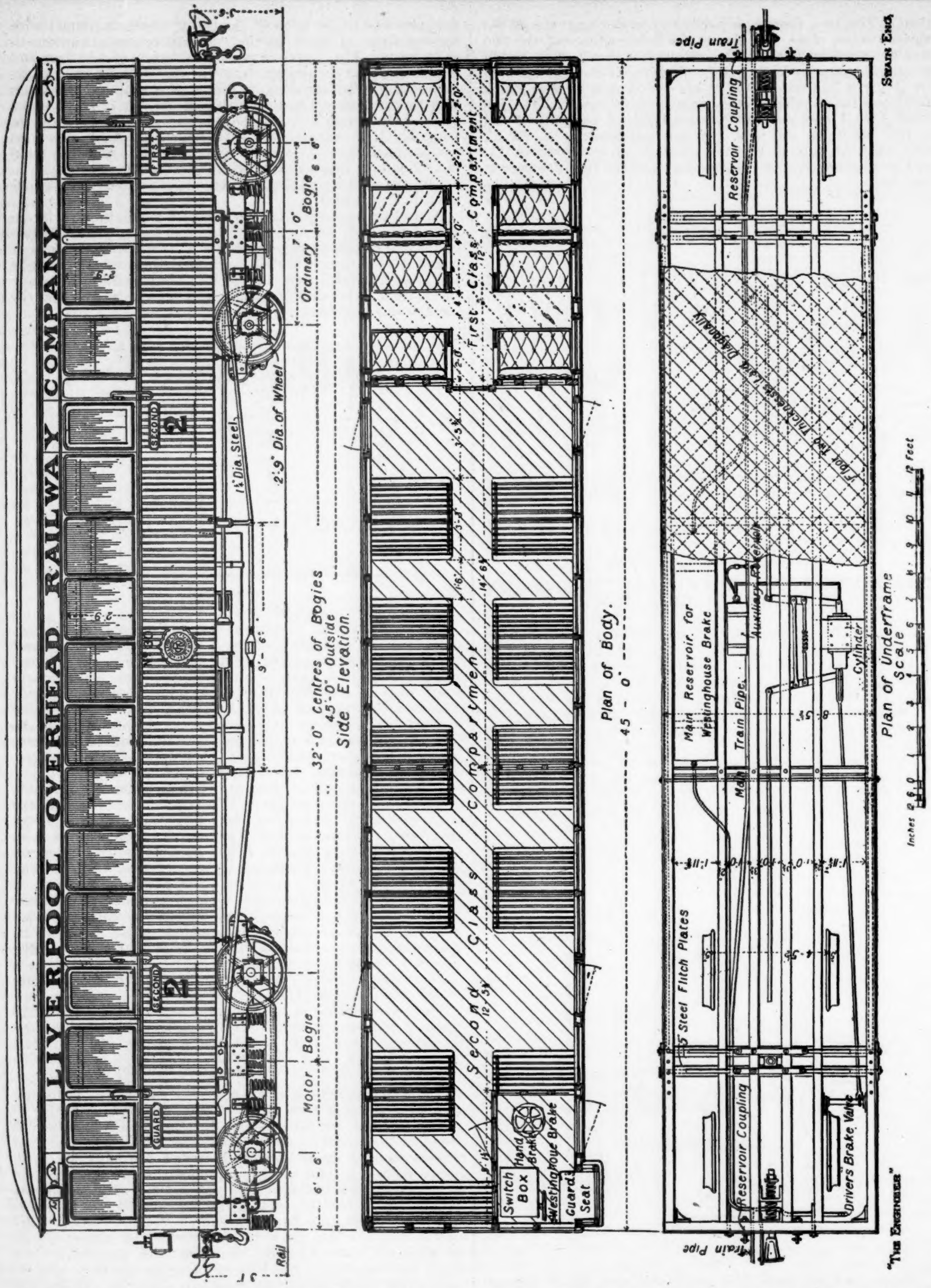
The cut-off circuit consists of simple lead plates which are placed in the feed-wires of each lamp, the general cut-off being a fusible wire placed by the side of the box which carries the battery, in order to avoid the dangers which would result from an abnormal rise in the intensity of the current. The accumulators used on the Jura-Simplon are of the Huber system. Each battery is composed of an ebonite case hermetically sealed, provided with ventilators and divided into three compartments, each inclosing an element formed of five plates. The battery contains nine elements connected in series.

The plates of each of them are formed by an unoxidizable alloy of lead and antimony. The plates are filled with the oxide of lead for the positive plate, with litharge for the negative plate. The pastilles are perforated, which permits them to expand freely toward the center without putting any strain on the lead grid; each element gives a tension of two volts. The capacity of the battery is about 120 ampère hours, or $120 \times 18 = 2,160$ watts hours. The maximum power of the discharge is about 5 ampères, and the normal discharge is 9.3 ampères, which corresponds to a power of about 170 watts. As the lamps used consume three watts per candle power, the intensity necessary for a difference of potential of 18 watts is .17 ampères, so that the battery can furnish 120 ampère hours = 705 candle power hours.

The normal power of the discharge of the battery being 170 watts, it can furnish lamps having a total luminous intensity of 171 watts ÷ 3 watts = 56 candle power, and the total duration of the lighting will be $\frac{705}{56} = 12.6$ hours.

The total luminous intensity of all the lamps of a car having now been brought from 30 to 35 candle power, according to the type of the car, the available duration from the battery is from 23 to 20 hours. First-class cars with three pairs of wheels running in international service are provided with lamps having a total luminous intensity of 70 candles, and these cars are also provided with two batteries of accumulators coupled up in parallel, so that the total duration of 20 hours can be obtained; the battery weighing 242 lbs. can be easily carried and put into place by two men. The weight is subdivided as follows: Case and liquid, 83.6 lbs., and plates, 158.4 lbs. The capacity of the battery being, as has been said before, 2,160 watts hours, the weight is equal to .112 lbs. per watt hour of capacity. This result is better than that which was obtained in the lighting done by the German Railway Commission at Frankford-on the-Main.

On each box there is a notice giving the number of hours, which must not be allowed to be exceeded before the battery is recharged. There is also an electro mechanical clock which is set in motion when the lamp circuit is closed. The dial of



the clock shows the number of hours during which the accumulators have been furnishing the current. It is divided into 30 hours, and has a red pointer, which indicates the starting-point. This very simple arrangement permits the inspector to tell at a glance whether there is any necessity for recharging. Each time that it is done the clock-pointer is set at zero. The principal stations are also provided with a supply of large accumulators. These accumulators are handled at the station on a four-wheeled truck, carefully hung so that there is no danger of shocks. The tray which contains the accumulators can be placed upon the ground without any danger of short circuiting, since the contacts are some distance from the bottom.

In order to avoid all causes of loss of electricity, resulting

from contact with damp objects, as well as to prevent shocks during the transportation of the accumulators from the truck to the car, occasioned by the splashing of the liquid, a litter is used for this purpose. When the battery is replaced, after having been working for the time marked on the car, a memorandum is made of the hour marked by the pointer, and the clock-work is set back so that the pointer indicates zero. The box is closed by raising the sash, which pushes the tray of accumulators back against the back of the box by means of rubber cushions, which prevent any sudden displacement, and also take up shocks due to the motion of the car. According to the report furnished by the company, the cost of this system of electric lighting is as follows: The available capacity of a battery is 2,160 watt hours; admitting the effectiveness of 70 per cent., it will be necessary to charge it with 3,100 watts. The power at Fribourg is delivered to the shaft of the dynamo at a cost of one cent per horse power hour, admitting an effectiveness of the dynamo of 90 per cent. and of the wiring 95 per cent. The cost rises to about 1.2 cents per horse power hour. The kilowatt hour then costs about 1⅝ cents per hour; the charge in the battery being 2.16 kilowatts for which the effective charge of 3.1 kilowatts is necessary, the cost of the battery is 5⅜ cents.

Coming now to the first cost, it will be divided under three heads: that of the electrical energy, the maintenance of the apparatus, and labor. As for the electric energy in a car lighted by the means of six incandescent lamps, with a total intensity of 50 candle power, the amount of energy acquired would be 150 watts for an average lighting of five hours per day, or 1,825 hours per year, the energy consumed will be 273.7 kilowatt hours, and the annual cost of lighting is about $5.

Maintenance of the Apparatus.—The lamps have the durability of 600 hours, each lamp must therefore be replaced three times a year, counting upon an average lighting of five hours per day. Lamps cost 40 cents. The expense of renewing will therefore be $7.20. The company manufacturing accumulators charge $5 per year for accumulators for maintenance. At the end of five years the company agree to replace the accumulators to the Jura-Simplon Road on a basis of a depreciation in their value of 8 per cent.

As the battery costs $66, and the annual depreciation is 8 per cent, we have the annual cost for depreciation of $5.28. The general plant of Fribourg cost about $4,000. We may take 40 per cent. of this, or $1,600 as applicable to that portion of the plant which is especially adapted for charging the accumulator. We may also take $1,260 as the cost for the car and equipments, giving a total expense of $2,860. This expense being divided among 120 batteries gives $23.50, of which interest and depreciation rated at 5 per cent amount to $1.17. Finally, the car apparatus being estimated at an average cost of $50, with interest and depreciation for the same at 5 per cent., we have $2.50. The total expense for the maintenance and depreciation of the car is therefore $33.01.

The expense for labor is about the same as that for lighting with oil, or $5.40 per year. The lamps would thus have an expense of $32.40 per car per year. Adding the above, we have

Electrical energy	$5 00
Maintenance and depreciation	33.01
Labor	32.40
	$70.41

These figures show that the cost of electric lighting by means of accumulators in Switzerland is far less than the cost of their method of oil lighting, but it would be imprudent to jump to the conclusion that electricity is the most economical method of lighting; since the Swiss are in a particularly favorable situation for electric lighting, as the current is furnished at the extremely low price of one cent per horse power hour.

The conclusions reached are that electric lighting for European cars is not practical by lighting each car with its own accumulator. Each compartment should possess two lamps, so that in case one is extinguished the other can furnish the necessary light, and recourse to lighting by candles or lamps should not be permitted.

Concerning the choice of the source of electricity, it is only by experiment of long duration that the system and style of accumulators best adapted for the work can be decided upon. The very fact that improvements have been made in accumulators in the past few years show that there is still room for further advancement, both from the standpoint of their durability and resistance to vibratory shocks. Finally, it is not probable that electric car-lighting can be practically introduced, except where the company can purchase the current at very reduced rates, or where they are already provided with their own generating stations.

PASSENGER CAR OF LIVERPOOL OVERHEAD RAILWAY.

We take from *The Engineer* an illustration of the side elevation and plan of the new cars which have been recently placed upon the Liverpool Overhead Railway. These cars are run in trains of two, and are 45 ft. long over all, with a width over side pillars of 8 ft. 6 in. The carriages are mounted on two four-wheeled bogies, one of which carries a motor, as shown. The distance between wheel-center of the bogie is 7 ft., and the wheels are 2 ft. 9 in. diameter. They carry 57 passengers, 16 first-class and 41 second class. As each carriage is fitted at one end with a driver's box and necessary switch and brake-gear for controlling the work, there is no shunting at the terminal stations, the driver changing ends. The gangway between the two cars gives a clear passage through for the guard.

The engraving of the plan shows very clearly the internal arrangement of the car. The motors on each train are on the leading and trailing bogies. Six incandescent lamps light each carriage, supplied with current from the center conductor, the same as the motors.

The carriages are fitted with Westinghouse brakes, with compressed air stored in receivers carried under the carriages, and these being charged by an air-compressing plant fixed at the generating station at the north end of the line. Hand screw brakes are also provided.

The armatures of the motors are mounted direct upon the axles. Ten revolutions of the axle per minute gives a speed to a car of one mile per hour. The maximum speed necessary to do the journey in the time specified is approximately 26 miles per hour, or 260 revolutions of the motor per minute.

SOME THOUGHTS ON BOILER INSPECTION.*

By John Hickey.

The simple words "boiler inspection" may be considered as meaning but very little, or they can be regarded as encompassing a great deal.

In its simplest form, the duty of a boiler inspector may be performed by the ordinary boiler maker, who, by a hasty glance, only observes the conditions of exposed surfaces and passes rapidly all parts not showing considerable irregularity of surface or having the appearance of leaks.

On the other hand, it may be said that the proper fulfilment of boiler inspection is far reaching; that such duties should commence with the manufacture of the plate; that it should include the tests which boiler plate is necessarily subjected to; that such inspection should guide and assist in reaching designs intended to meet certain demands and requirements under well-established conditions.

The duties of inspection should establish and conduct the tests which a complete boiler is required to undergo; it should outline the character of the test power, decide how long such test should be maintained, and what to be observed during the operation. Inspection duties lead on to the boiler in service, where it must institute the most critical examination as to how the several parts are performing required duty; must direct special attention to the extent of deterioration in part or as a whole; and finally, pass on the methods pursued by persons charged with its care and management.

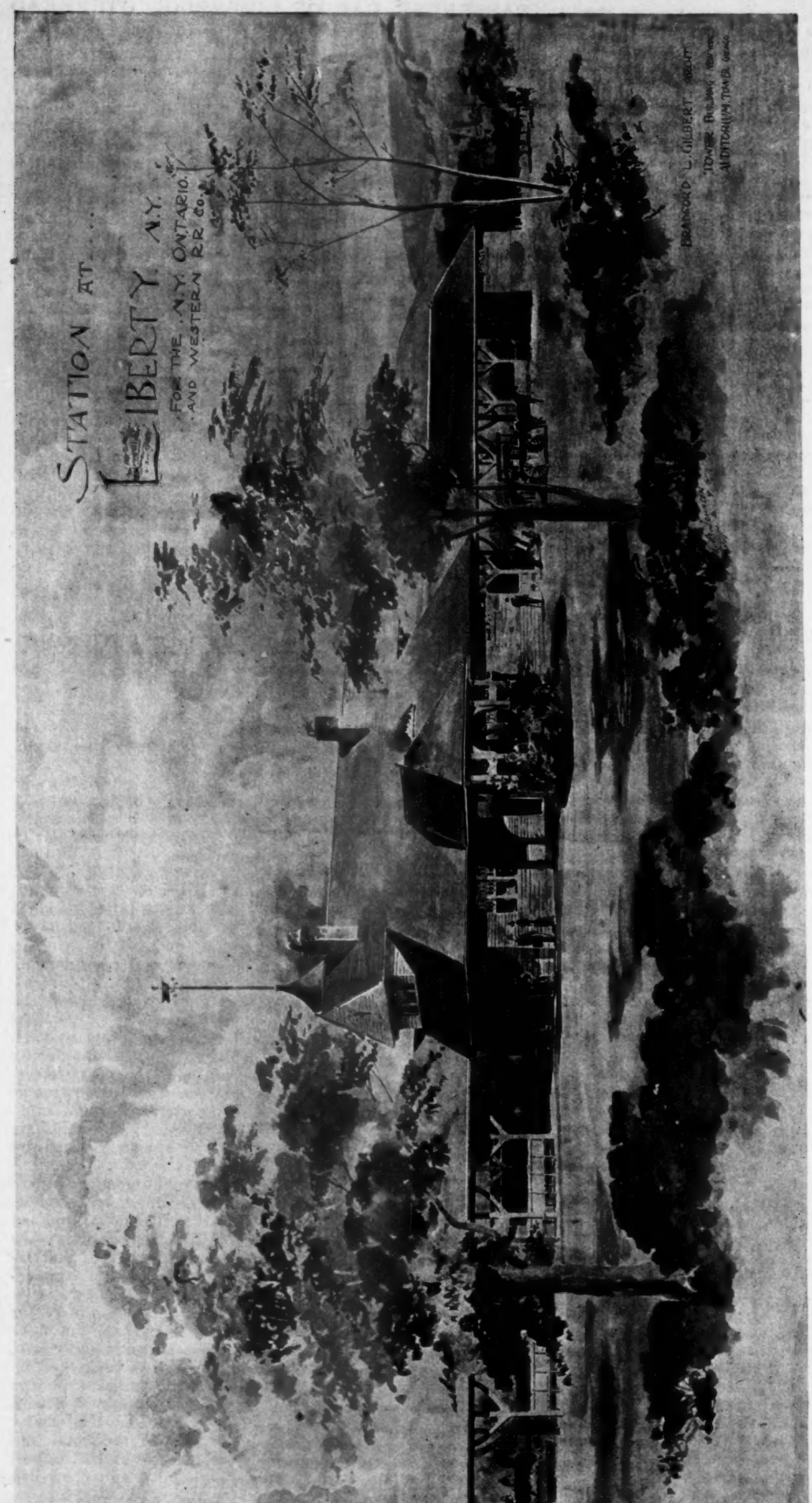
Briefly stated, then, boiler inspection should commence with the manufacture of the boiler plate, pass successively on its strength and endurance, on the design and construction, on the manner of conducting and treatment in testing, observe its performance in service, establish periodical testing, and institute the most intelligent methods for its care and management.

What constitutes in detail the full duty of a boiler inspector cannot be considered in a short paper; a volume could be written on this point alone. What is stated must necessarily be local and passing. Essential points only can be treated.

Inspection duties should commence with the manufacture of the plate, where alone all the circumstances connected with its quality and manufacture can be ascertained. Uniformity of thickness in each plate, homogeneousness of the metal, and exceptional freedom of lamination are features of the highest importance in boiler plate. This is especially true of fire-box plate.

Passing next to its tensile strength, which practically means a certain strain applied and constantly increased until the result produces rupture, the amount, or percentage, of elonga-

* Paper read before the Northwest Railroad Club.



tion should also be noted. This element is displayed by the metal between the load at the elastic limit and that at the limit of tensile strength. Really the elongation power of boiler plate is an important feature. It establishes the ductility of the metal and makes known its ability to adjust itself (without endangering the safety of the boiler) to the elements of expansion and contraction; and reasonably must be considered a factor in its endurance.

The limit of elasticity must also be determined and accurately established. This is the amount or extent of strain which may be applied to metal, causing it to elongate to the extreme point, where, on the removal of the strain, it returns to its original dimensions. The stress denoting the elastic limit in boiler plate should form the basis for calculating the strength of the boiler. The reason for this is obvious when it is considered that, while the elastic limit of the plate may fall far short of its ultimate capacity, the stress which caused the metal to reach this limit will, if frequently applied, soon exceed the elastic point and make way for permanent set; and a continued application of this, or perhaps a less load, will ultimately cause fracture.

Passing to the design and construction of a boiler, both of which should be under the eye and subject to the advice of the experienced inspector, at this point it may be proper to call attention to the fact that, of all other structures we are called on to design, those of boiler dimensions in details are the most important.

The boiler, with its relative parts, is the most important part of the locomotive. On its power to meet necessary requirements depends to a great extent the economy and efficiency of our lines of transportation. There are some grounds for the belief that, if the design and dimensions of locomotive boilers were given thought to as great a degree as that directed to improving the compound principle in locomotive engines, the result would be much more satisfactory in the directions of both economy and efficiency.

In all parts of boiler erection the inspector should play a ruling part and should be granted the greatest freedom in reaching conclusions as to the character of the work performed. There is scarcely a doubt that the strength and quality of boiler plate are often overtaxed and unduly strained while in the hands of a boiler-maker. The plates have to undergo the various

processes of heating and cooling, hammering hot and cold, bending, twisting, flanging and punching, to say nothing of the evil of the drift-pin or of hidden defects which are likely to occur in the plate.

There is certainly a possibility of bad and careless riveting, plates over heated in flanging, or cracked, if only slightly, in bending, and many other defects which may be traced to want of skill or reckless negligence on the part of the workmen.

It is clearly evident that the material for a boiler may be of the most superior quality sanctioned by use, and yet if not skilfully handled and most carefully attended to during the process of preparation to take its place in the completed boiler, it may be reduced to a point less in strength and endurance than material of the most inferior grade.

If we are to take the strength of the plate and the value of the joints, as they appear at their best in the finished boiler, as a means of ascertaining its resisting power and factor of safety, how uncertain it might be if we neglected to inspect and investigate in detail the methods followed in its erection.

The writer has seen, however, some cases of dangerous defects due to poor construction, which the strictest scrutiny of the completed boiler would fail to detect, brought to light by the test power combined with careful inspection. It is, however, a much better plan to compel carefulness in construction.

Opinions differ as to the best means of applying pressure in order to ascertain the strength of a boiler. Some advocate the hydraulic, others the steam test. In favor of testing by steam, it is urged that it is the only means by which the conditions of strain can possibly be the same as those under which the boiler is worked. No doubt this is in the main true, but as a matter of safety a steam test should only be applied after the strength of the boiler has been ascertained by the water test.

In making a full test of a boiler, new or old, before a pressure is applied, the various parts, particularly those suspected of weakness, should be measured and gauged and the results carefully noted. After the test pressure (which should not be more than 40 per cent. in excess of the working pressure) is maintained for some time, the measurements previously obtained should be checked, and any extension, changes of form, distortion, bulging, etc., carefully noted. Then, again, after the pressure is released any changes in measurements that may have been found should be known, whether permanent or not; and it seems to the writer that right here is a highly important point, one that should receive the most serious thought in that, if there be any permanent enlargement or distortion, even in the slightest degree, it should be thoroughly examined to decide whether it is due to the elastic limit of the material having been exceeded, or to improper construction. In all cases where permanent set is discovered the test should be repeated again and again if necessary, in order to ascertain if the set becomes increased.

In whichever manner a boiler is tested too great care cannot be exercised in obtaining the exact amount of pressure applied. Gauges in general use are too apt to get out of order to be implicitly trusted, when only a single gauge is used. It is, therefore, urged and recommended that in all cases of important boiler testing not less than two gauges be used, in order to establish to a certainty the exact pressure applied.

It may be remarked here that the test pressure should be maintained for some considerable time, say, half an hour or more. The continued pressure has often been known to lead to the detection of weakness, when, if such pressure had not been maintained, the defect would have escaped unobserved.

The question as to whether a boiler is strained more severely by steam than by hydraulic pressure will be found to resolve itself almost entirely into the question of construction. It is possible to design a boiler that would explode at low steam pressure and which would not be unduly strained by a hydraulic pressure three times as great. A boiler being steamed is often strained in a longitudinal direction, mostly in unequal expansion of the top and bottom shell, due to the greater expansion of the tubes, especially when the firing is forced, in getting up steam after the boiler has been cold. As this straining would not take place in testing the boiler with hydraulic pressure, and leaks due to unequal expansion would not be produced, it follows that the hydraulic test must fail to indicate weakness, which must be produced and made apparent by the steam test. From this it would appear that all boilers when new, or newly repaired, should be tested first by hydraulic pressure, and after by steam, the latter to determine what, if any, unequal expansion exists, to what extent, and what results have been produced.

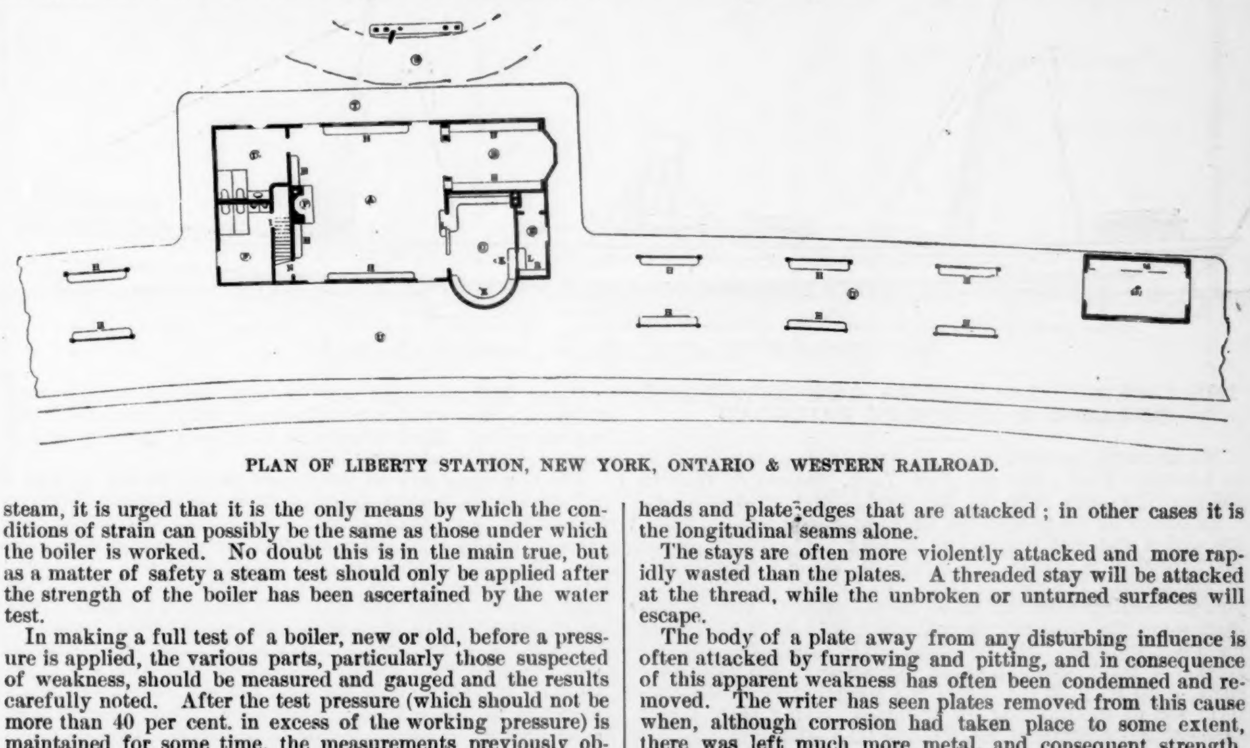
The wear and tear of a boiler in service is an important feature for the inspector to keep in mind. From the hour the boiler is set at work it is acted upon by destroying forces, and many of them are almost uncontrollable in their work of deterioration. Internal corrosion is the malady that most boilers suffer from. Corrosion presents itself in various forms. Sometimes it happens that it is mainly the transverse seams, rivet heads and plate edges that are attacked; in other cases it is the longitudinal seams alone.

The stays are often more violently attacked and more rapidly wasted than the plates. A threaded stay will be attacked at the thread, while the unbroken or unturned surfaces will escape.

The body of a plate away from any disturbing influence is often attacked by furrowing and pitting, and in consequence of this apparent weakness has often been condemned and removed. The writer has seen plates removed from this cause when, although corrosion had taken place to some extent, there was left much more metal, and consequent strength, than was possessed by the next section of the plate through the rivet holes. This is an expensive mistake, and inspectors ought to guard against it.

As corrosion, as a whole, on the inside of a boiler is one of the most destructive elements we have to contend with, periodical inspection of its inroads must be made and met with the highest degree of care and intelligence. Of course the frequency of such inspection must depend on local conditions, essentially on the proportion of the destructive power contained in the water used and the relative amount of water evaporated.

Much is lost by improper care and unintelligent management of boilers in service. It seems unnecessary to remark that the management and care of boilers should be treated with as great a degree of intelligence as their design and construction. Excellent points to avoid are sudden and unequal expansion and contraction as a whole or in part. Blowing out a boiler while hot and washing it out with cold or comparatively cold water immediately thereafter is one of the most destructive and expensive practices of the service. Rapid and forced firing in a boiler which has been out of service and permitted to cool is also a boiler evil of the highest order. Permitting the entrance of cold air through the door

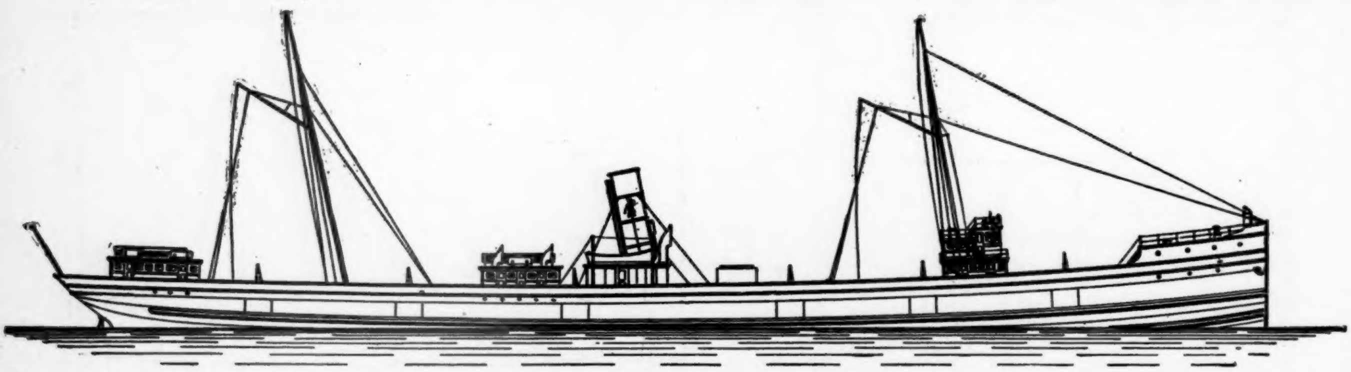


PLAN OF LIBERTY STATION, NEW YORK, ONTARIO & WESTERN RAILROAD.

or dampers immediately following the dumping of the fire is on a par with the worst evils, and its result is always apparent by the development of leaks.

To the correction of such disturbing elements as the above, together with numerous abuses in the care of boilers, it is desired to direct the attention of inspectors, but the extent of correction will depend largely on the intelligence and common sense of the persons charged with inspectors' duties. It is readily seen that on the proper fulfilment of boiler inspection depends much public comfort, public expenditure, and safety to public life and property. To perform the duties of boiler inspectors conscientiously and well the position can be no sinecure, and it can only be successful with the aid of experience in boiler design, construction, and requirements, together with a full understanding of the direction in which the forces are applied while in service, as well as under the stresses of test.

Do we hear mutterings among co-workers that this advice relating to the qualification of a boiler inspector is good enough, but is much easier stated than obtained? Begging to assure you that we are aware of this, gentlemen, let us inquire whose fault it is. Is it not to be laid to the indifference of the men long in charge of machinery departments, in not encouraging the required attainments in reaching proper boiler design and construction, and not appreciating to the proper extent those qualifications when presented?



THE "CENTURION," BUILDING BY F. W. WHEELER & COMPANY.

THE LIBERTY STATION OF THE NEW YORK, ONTARIO & WESTERN RAILROAD.

We illustrate herewith the station which is now being built at Liberty, N. Y., for the New York, Ontario & Western Railroad Company, with Mr. Bradford L. Gilbert as architect.

As shown by the perspective drawing, it is a wooden building with a long platform and an awning. At each end of the platform there is a small baggage-room, and at the south side of the building is a *porte-cochère*. On the first floor there is a general waiting-room, which is 28 ft. square. Off of this there opens the woman's alcove, which is 13 ft. × 19 ft., and has a bay window. The telegraph office, which occupies that portion of the building between the woman's alcove and the track, is 20 ft. × 12 ft. There is a special entry on the platform end of the building for trainmen, giving them direct access to the telegraph office, and is 5 ft. × 11 ft.

The woman's toilet is 13 ft. × 13 ft., and the men's 9 ft. 6 in. × 14 ft. 6 in. On the second floor is the operating-room and office. The former is 15 ft. 6 in. × 20 ft., and the latter 8 ft. × 16 ft. The plan and perspective give a very clear and distinct idea of the general appearance of the station, which is 29 ft. wide and 60 ft. 6 in. long, while the awning is 20 ft. wide at its widest part.

F. W. WHEELER & COMPANY'S ONE HUNDREDTH VESSEL.

"Centurion" is to be the name of the one hundredth vessel to be built at the yards of F. W. Wheeler & Company, West Bay City, Mich. The keel for this steel freight steamer was laid on Thursday, March 2, the fortieth birthday of Mr. Wheeler, and was made the occasion of a banquet at the Fraser House parlors, in Bay City.

One of the modern features of the *Centurion*, which is included also in Nos. 94 and 95, building at this yard for the Hawgood & Avery Transportation Company and D. C. Whitney, Detroit, is the placing of the engines and boilers amidships, thus lessening the strains to which the hull is subjected when boilers and machinery are placed aft. This is a departure from the usual practice of lake builders, and is adopted for the first time by F. W. Wheeler & Company. A glance at the accompanying photogravure illustration will give the best idea of what the most modern freight steamer on the lakes will look like when completed. The following are her principal dimensions: Length over all, 378 ft. 6 in.; length of keel, 360 ft.; breadth, extreme, 45 ft. 2⅝ in.; breadth, molded, 45 ft.; depth, molded, 26 ft.; depth of hold 13 ft. 2¼ in.; height between decks, 9 ft. 2 in.; height of forecastle, 7 ft. 6 in.

Especial care has been taken in her scantlings to place her in the highest class obtainable both in the American Shipmasters' Association and the English Lloyds, the rules of which she exceeds in many cases. All the material used in her construction is tested to stand a tensile strength of 60,000 lbs., with an elongation of 25 per cent. in 8 in., and is of the best open hearth steel.

Another feature is that the shell plating butts will be overlapped instead of butt strapped, and riveted throughout with three complete rows of rivets. In riveting, steel rivets will be used, which will give greater sheering strength. All stringers and longitudinal butts will be treble riveted throughout, and the spar deck stringer is double butt-strapped, especial care being taken to insure both in shell and longitudinal ties a clear shift of butts of from two to three frame spaces. Two 20-in. hold stringers aside run her entire length, and an extra one is fitted in the fore hold, which will extend through the collision bulkhead and will be connected to the panting stringer, which will prove a factor of safety in case of meeting heavy ice. Her forefoot will be cut away in ocean style to allow her to be quick on the helm.

The *Centurion* will be fitted with water ballast, having a cellular double bottom differing from the ordinary floor system employed in lake practice. The bottom will extend fore and aft, will be 54 in. deep, and will have a capacity of 1,600 tons, and there will also be a trimming tank aft. The sheer strake is extra heavy, and doubled for the entire length of the vessel. Web frames are spaced 16 ft. apart throughout the vessel, extending to the spar deck, and the deck beams are supported by three tiers of extra heavy I stanchions. She has been designed with special reference to the safe and quick handling of both package and bulk cargoes, every modern appliance in the shape of deck winches and steam hoisting gear being adopted to carry out this aim; between hatches in between decks are placed six large gangway ports on each side, thus insuring dispatch in loading and unloading cargo. The American Ship Windlass Company, Providence, R. I., furnish the No. 6 steam windlass and the E pattern steam capstan. These machines are too well known to necessitate a description. The steam steering engine is by Williamson Brothers, Philadelphia, and is arranged for both hand and steam. The engine is placed amidships, and is easy of access from the main engine-room.

The boat will be lighted throughout with electricity, having a 210-light dynamo, operating under 110 volts. One hundred and twenty-five 16-candle power incandescent lights will be distributed in the different cabins, and for lighting the decks six large lights are furnished. The cabins will be well ventilated and roomy, and elaborately finished in hard wood, the captain's and spare cabins being in the style of Louis XVI., making them equal to the best passenger boats on fresh water. The rig will be a fore-and-aft schooner with two pole masts well raked, and standing gaffs. The pilot house and texas will be well aft, which will add to the appearance of the boat, making her more ocean-like than the usual lake style of steamer.

The *Centurion's* motive power will consist of a modern triple-

expansion engine, built by F. W. Wheeler & Company in their own shops, with cylinders 23, 37½ and 63 in. × 44 in. stroke, driving a Trout wheel of 13 ft. 6 in. in diameter. The cylinders are placed in the sequence of high, intermediate and low pressure. The valves are actuated by the ordinary Stephenson link motion. The high-pressure and intermediate-pressure cylinders have each a piston valve, and the low pressure cylinder has a double-ported balance slide valve. The links are of the double barred type, and the motion is reversed by steam, the diameter of reversing cylinder being 12 in The bedplate is cast in one piece, and the framework consists of three straight cast-iron columns on the starboard side, and three Y-shaped columns on the port side, having very large bearing surfaces for the slides, and through bolts are used throughout. The cross-heads and connecting-rods are forged of the very best wrought iron. The piston-rods are 5⅝ in. in diameter, of the very best machinery steel. The crank shaft is built up, and has a diameter of 12 in., the cranks being set at an angle of 120°. The thrust shaft has four large thrust collars, proportioned for a maximum thrust of 60 lbs. per square inch. The intermediate shafting is 12 in. in diameter and in 20-ft. lengths, supported by six line shaft bearings. The stern tube is fitted with an internal lignum vitæ bearing 5 ft. long. The center of the engine is placed 132 ft. from the after side of the stern post, and has a tunnel of ample size to allow free access to the whole length of shafting.

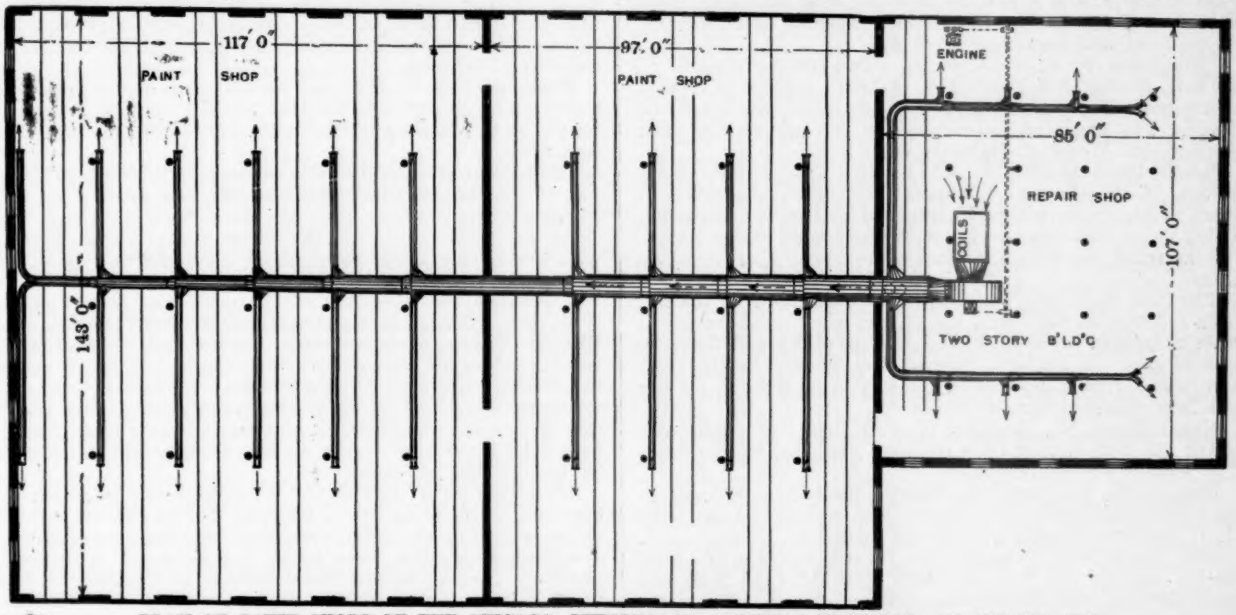
The condenser is independent, of Dean Brothers' type, the feed pump, duplex feed pump, bilge pump, cooler pump, deck pump and ballast pumps being supplied by the same company. The ballast pump has a capacity of 3,000 galls. per minute for emptying all the ballast tanks. Steam will be furnished by three cylindrical boilers of the return tubular type, 12 ft. 6 in. in diameter and 12 ft. 8 in. long, working at a pressure of 170 lbs. Each boiler has three 40-in. diameter furnaces, the total grate surface being 190 sq. ft., and the heating surface will be 6,500 sq. ft. The coal bunker capacity is 250 tons. A feed water heater of 24 in. in diameter is fitted on the line of feed piping containing fifty four 1¼-in. brass tubes 8 ft. long, and three double tube injectors are also fitted in addition to the feed pumps. The main steam pipe is provided with necessary slip joints, and is made of copper, carried below deck, as also are the receiver and exhaust pipes into condenser. The ship is to be heated with steam throughout.

When 23 years old, Mr. Wheeler established a small repair yard at West Bay City, and during the first three years built six small vessels, in addition to doing considerable repair work. But in 1880 he commenced building large wooden steamers, and in that year turned out the *Lycoming* and *Conemaugh*. In 1889 the steel plant was established, and work was commenced on the steel hull side-wheel passenger steamer *City of Chicago*, and she was completed in June, 1890.

PAINT SHOPS OF THE CHICAGO, BURLINGTON & QUINCY RAILROAD, AURORA, ILL.

We illustrate the ground plan of the paint-shops of the Chicago, Burlington & Quincy Railroad, at Aurora, Ill., which have been equipped with the Huyett & Smith Manufacturing Company's heater and blower. The blower is set on the second floor of the repair shop building, and the pipes run along the roof-timbers of the two paint shops, which are each 22 ft. high. The paint shops themselves are only one story high, but are 22 ft. from floor to ceiling or roof-timbers, as we have already said. The repair shops are two stories high, one of 17 ft. and the other of 13 ft. respectively. Just before the main pipe passes through the first wall a branch pipe is taken out and run along the ceiling of the first floor of the repair shops, as shown in the engraving, which heats the second floor. Branch pipes from the main line which enters the main paint shops lead off and run along the ceiling to the first post, when they turn down and down to within about 7 ft. of the line, and discharge toward the outer wall, as shown. These branches are 12 in. in diameter, while the main pipes vary from 16 in. at the farther extremity to 54 in. at the delivery from the fan. The coil contains 12,000 lineal ft. of 1-in. steam pipe. The fan is a 96-in. steel plate blower, which at a minimum speed will produce a pressure of ¼ oz. per square inch, which is sufficient to change the entire air in the building every 16 minutes, while if delivering at a pressure of 1 oz. the entire air will be changed every 8 minutes. The blower is driven from a counter-shaft on the ceiling of the first story, which is in turn driven by the vertical engine on the first floor next to the outer wall.

Live steam is used in the heater in cold weather, and exhaust steam in mild weather, or the two may be commingled as desired; the steam enters the coils from the top header in the upper left-hand corner, and passes out through the header in the lower right-hand corner to the drip pipe.



PLAN OF PAINT SHOPS OF THE CHICAGO, BURLINGTON & QUINCY RAILROAD, AT AURORA, ILL.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

We begin herewith the publication of a monthly list of accidents to locomotive engineers and firemen. The purpose of this publication is to make known the terrible sacrifice of life and limb among this class of people, with the hope that the collection and publication of information, as full as is obtainable, will indicate some of the causes of accidents of this kind and help to lessen the awful amount of suffering due directly and indirectly to them. We will be much obliged for any information from any source which will help us to make our list as complete and correct as possible, and which will indicate the causes or the cures for any kind of accidents which occur. The following list includes only a portion of the accidents which occurred during the month of February:

ACCIDENTS IN FEBRUARY.

Rome, N. Y., February 14.—A New York Central fireman, named Schlieper, fell from a locomotive near Rome, N. Y., to the ice, 12 ft. below a bridge, and was so badly hurt that recovery was thought to be hardly possible.

Erie, Pa., February 13.—An engine on the Nickel Plate Railroad left the track near Wallace Junction while the train was running at a high rate of speed, and turned at right

angles to the road, "bounced over," crushing William Lipwalder, the fireman, to death. Engineer O. W. Wilkins was also buried in the debris, but at the time the accident was reported he was said to be still alive.

Bristol, Tenn., February 13.—At Norton's Summit a freight train ran off the track and rolled down the mountain a distance of 100 ft. Engineer Allen was killed and Fireman Pettijohn was seriously injured.

At about the same time a freight train ran into a slide at Seven Mile Fords. The engine and six cars were precipitated down a hill, and Engineer John Smith had one leg broken and was otherwise injured. Fireman Marion was seriously hurt.

Portsmouth, O., February 16.—An engine on the Cincinnati, Portsmouth & Virginia Railroad was ditched at Coe's Station by striking a landslide. John Sprague went over with the engine, and was so badly scalded that he will die. The engineer jumped and saved himself.

Baltimore, O., February 16.—John Hahn, a fireman on the Baltimore & Ohio Railroad jumped off an engine at Light and Wells streets and slipped as he jumped, fell under the enginis which ran over him, crushing his right leg and left foot. He, leg was amputated, but his condition is critical.

Lockport, N. Y., February 16.—Herman Reck, a Buffalo, Rochester & Pittsburgh engineer, was killed in a wreck about two miles south of Springville.

Indianapolis, Ind., Feb. 16.—A "driving-rod" (?) on an engine on the Peoria & Eastern Railroad, near Moreland, broke and crashed through the cab, striking Andrew Losh, fireman, on the head, and fracturing his skull.

Springville, N. Y., February 17.—Two freight trains on the Buffalo, Rochester & Pittsburgh Railroad collided at Hayest. Herman Wreck, engineer of one of the trains, was fatally injured. The engineer and fireman of the north-bound train jumped, but Wreck stuck to his post.

Brazil, Ind., February 17.—A through freight train, north bound, on the Chicago & Indiana Coal Road, was stalled on Bush Creek grade, and was compelled to stop for assistance. Being aware that two heavy freight trains were closely following his train, the conductor sent a brakeman back to signal them.

The first train was stopped, but the engineer of the rear train failed to see the signal and dashed into the caboose of the train in front of his own, tearing it all to pieces and derailing several cars. E. Jackson, fireman, was crushed in the chest and became frantically insane, and had to be held to prevent him from jumping into the flames.

New Concord, O., February 17.—The boiler of engine No. 103 of the Baltimore & Ohio Railroad exploded at Norwood. The fireman was badly scalded.

Easton, Pa., February 18.—George Bimbler, a fireman on the Central Railroad of New Jersey, was injured at Annandale, N. J., and was reported in a critical condition.

Fort Worth, Tex., February 19.—By the explosion of a locomotive boiler on the Texas & Pacific Railroad, John Mills (colored), fireman, was horribly mangled and killed. Five other persons were injured. The fire-box, it is said, "blew off," and the cause assigned was weak stay-bolts and flues.

Brooklyn, N. Y., February 20.—An engine on the Prospect Park & Coney Island Railroad was derailed—it is said by a gale—and the fireman and engineer were injured.

Palmyra, N. Y., February 21.—A passenger train on the West Shore Railroad was derailed near this place and thrown down an embankment about 18 ft. high. Bert. Pearsall, the engineer, was badly hurt, and Fred Mentle (or Minth), the fireman, was seriously bruised.

Reading, Pa., February 21.—A shifting engine on the Pennsylvania Schuylkill Valley Railroad collided with a freight train near Spring City. Fireman McCord was seriously injured, and two men on the train were killed and two others injured.

Trenton, N. J., February 22.—In a collision at the Calhoun Street crossing, Engineer Weir was caught by the falling cab of his engine and pinned fast, so that he had to be pried out. He was only slightly hurt.

Willoughby, O., February 23.—A Lake Shore special train ran into a "light" engine at Wicklife at four A.M., killing Engineer James Gill of the extra. He was pinioned in the cab, with the lever through his body, and was otherwise horribly mangled. His fireman has not yet been found.

Cadillac, Mich., February 25.—Freight engine No. 40 blew up four miles south of this city on the Toledo & Ann Arbor Road this morning. Fireman Pat O'Neal was killed, his head being badly crushed and an arm torn off.

Naugatuck, Conn., February 24.—Edward Cosier, fireman, and Mr. Abel, engineer, were slightly injured in a wreck.

Augusta, Me., February 25.—The "driving-rod" of an engine on the Maine Central Railroad broke and went through the cab, throwing the engineer, Fred Little, out and fracturing his arm.

Westchester, Pa., February 25.—An engine ran into a number of cars near Birdsboro, on the Wilmington & Northern Railroad. The cab of the engine was partly demolished. Mr. Hertlicker, the engineer, was thrown out of the cab by the force of the shock, and down through the trestlework of a bridge which spans a small stream at that point. He was injured internally and had several ribs broken.

New Haven, Conn., February 27.—In a collision in the cut between Court Street and Grand Avenue, Fireman Charles Bedell was crushed by the falling cab. His left hip was fractured, his left leg was broken, and he received internal injuries which were supposed to be fatal. He and his engineer stood bravely to their posts. Railroad officials said that the trouble was owing to the unexpected standstill of the local freight and the slippery rails, which would not allow the brakes to be effectual in a short distance.

St. Johnsbury, Vt., February 27.—In a collision of two freight trains on the Passumpsic Division of the Boston & Maine Railroad, near St. Johnsbury Centre, Fred Clark, engineer of the up train; Charles West, an engineer, who was riding on the same engine, and Fred Green, fireman on the down train, were killed. William Dowling, a brakeman, was hurt about the head, but not seriously. Engineer Napoleon Bedard, of the down train, saved his life by jumping. None of the other train hands were hurt. Fred Clark was living when first found, but died before he could be extricated from the ruins. The accident, it is said, was caused by the conductor forgetting his orders.

Washington, D. C., February 27.—A north-bound passenger train on the Pennsylvania Railroad collided with a side-tracked freight on the causeway of the long bridge crossing the Potomac River.

The engines of both trains were wrecked. Fireman Simpson, of the freight, was killed, and Engineer Mullowney and Fireman Kormik, of the passenger train, badly injured.

The telegraph operator at the bridge was arrested, charged with having caused Simpson's death by a failure to close the switch.

Meyersdale, Pa., February —.—A west-bound freight on the New York, Chicago & St. Louis Railroad left the track near Girard. The engine was totally wrecked, and Fireman William Lipwalder, of Mossiertown, was crushed to death under the tender. Engineer G. W. Wilkins, of Conneaut, O., was reported dead from injuries received, but was still alive at the time this report was made, though badly hurt. Head Brakeman John Walters, of Conneaut, had an arm broken and was badly hurt about the head.

Brooklyn, N. Y., February 27.—Engineer Lafayette B. Marshall, of the Long Island Railroad, had his foot amputated by the wheels of his engine yesterday. Marshall was running a wildcat locomotive from Long Island City to Whitestone Landing. At the Bridge Street Station, in Flushing, to side track his engine so as to allow the 2.11 train from Whitestone to pass, Marshall ran ahead and turned the switch, the engine following slowly. As the engine cleared the switch he attempted to jump on one of the side steps, but missed his footing and slipped beneath the wheels. His right foot was cut off at the ankle.

Terre Haute, Ind., February —.—While a fireman named Bean was making his first trip as fireman on Vandalia engine No. 267, he got down near Marshall, Ill., to stoke the ashes from the grate-bars, lost his balance, and fell frome the train, which was moving at the rate of thirty miles an hour. He was badly hurt internally about the head.

OREGON'S CANTILEVER BRIDGE.

ALFRED B. OTTEWELL read a paper before the American Society of Civil Engineers upon combination bridges on the Pacific Coast. He confined his observations, however, to two examples, which he said had already stood tests as severe as any which will be brought to bear upon them. The first bridge referred to is the cantilever bridge across the North Umpqua River, near Roseburg. Of this Mr. Ottewell says:

"It is, as far as the writer is aware, the only combination cantilever of large span in existence. The shore arms are each 147 ft., the river arms 105 ft., and the suspended span 80 ft., making the distance between river piers 290 ft., and the distance between end or anchor piers 584 ft. The bridge, as constructed, illustrates the principle of the cantilever very simply. The river span is connected and supported by the river arms at four points only. The weight of the river span is balanced about the river piers by the anchor piers or weights at the outer end of the shore spans. As will be seen, there is

no connecting member between the hip panel points of the suspended span and river arms, the wind pressure on the upper chord of the suspended span being transmitted down the end brace to the bottom chord of the cantilever arms to the earth. The lower part of each pier is built of concrete, set on the solid rock of the river-bed. The upper part of each pier consists of two iron cylinders, filled with concrete, and braced by wrought-iron horizontal struts and diagonal ties. The bracing is protected from drift by timber sheathing on each side of the bracing. The up-stream cylinder was anchored down to the concrete base by two 1¼-in. galvanized iron rods, to increase the stability against drift. The smallness of the anchor piers is due to the unusual length of the shore arm as compared with the river span. As usual in the superstructure of combination bridges, the floor beams, joists, floor and railing are of wood. The compression members are of wood, with the exception of the struts and bottom chord panels next the river piers, which are of steel. The tension members are of iron, and the pins of steel; the chord-blocks, post-shoes, etc., being of cast iron. The shore arms were made of unusual length, so as to offer as little obstruction as possible to drift, of which there is considerable in the rainy season. The method of erecting the suspended span, without false work by working out from the river piers, was, to some extent, different from the usual method adopted for iron construction, since the compression members in combination work will not in themselves take tension, nor the tension members take compression; nor will any member take transverse loads or shear. For these reasons it was found necessary in the course of erection to introduce several temporary ties and struts.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

II.—METHOD OF DETERMINING FREE CAUSTIC AND CARBONATED ALKALI IN SOAPS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 18, Volume LXVII.*)

OPERATION.

Put into an 8-oz. flask 100 c.c. of an alcoholic solution of stearic acid whose strength in terms of standard alkali is known, and add 5 grams of the soap cut in fine shavings. Allow to dissolve at a temperature near the boiling point of the solution. As soon as solution is complete titrate the excess of stearic acid with standard alkali, using phenolphthaline as indicator. Now filter the solution through paper or through asbestos in Gooch crucible, using the pump, and wash with absolute alcohol until the last drop of the filtrate, evaporated to dryness on a clean piece of platinum, leaves no residue. Dissolve whatever is left on the filter in warm water, and wash with water until same test as above shows no residue. The solution and washings should amount to about 100 c.c. Add now enough standard sulphuric acid to render the solution distinctly acid to litmus paper after boiling, and boil not less than 15 minutes. Then titrate the excess of acid with standard alkali, using phenolphthaline as indicator. These two titrations show the total amount of free caustic and carbonated alkali in the soap.

Dissolve another portion of 5 grams of the soap, which has been previously cut in very thin shavings, and after weight has been dried at from 120° to 200° F., in the same kind of a flask, in 100 c.c. of absolute alcohol, using heat as before. As soon as solution is complete filter as before, and wash with hot absolute alcohol until the last drop of the filtrate, evaporated as before, shows no residue. Dissolve whatever is left on the filter in warm water and wash as before; then render acid with standard sulphuric acid, boil and titrate as before. This last titration gives the amount of carbonated alkali in the sample, and the difference between this and the sum of the first two titrations gives the amount of free caustic alkali in the sample.

APPARATUS AND REAGENTS.

The apparatus required by this method is simply flasks, burettes and pipettes, none of which need especial description. We use ring-necked, flat-bottomed flasks, holding about 8 oz., burettes of 50 c.c. capacity, graduated to tenths, which have been calibrated and compared with each other, and 100 c.c. pipettes, which have been compared with the burettes.

The stearic acid solution is made by dissolving 15 grams of stearic acid obtained in the market in 2 liters of commercial 95 per cent. alcohol.

The phenolphthaline solution is made by dissolving 5 grams of the commercial material in 100 c.c. of 95 per cent. alcohol, and adding caustic potash until the solution shows slight pinkish tint.

The standard alkali and acid solutions are made as follows: Take about 50 grams of the best dry C. P. carbonate of soda, free from silicate, to be obtained in the market. Dissolve in distilled water and filter into a platinum dish. This is to remove any sand or dirt that may be accidentally contained in the soda. Add a little carbon dioxide or a few drops of carbonic acid water, in order to be sure that there is a slight excess of carbonic acid present. Evaporate the solution to dryness at a temperature a little above the boiling point of water, using great care to keep out the dust or dirt. When thoroughly dry transfer to a dry glass-stoppered bottle for further use. Now carefully weigh a clean ½ oz. platinum crucible and add to it about a gram of the dried carbonate of soda, ignite over a Bunsen burner until the soda is just melted, and weigh. This weight gives the amount of carbonate of soda used, and is the basis of the standardizing. Have previously prepared two solutions made as follows: 1. A solution of distilled water to which has been added about 26.5 grams of concentrated C. P. sulphuric acid per liter. The solution should be thoroughly mixed, and allowed to cool before using. 2. A solution of caustic potash in distilled water, made by adding to it about 50 grams of commercial stick potash per liter, allowing to dissolve, and then adding to it ½ liter of milk of lime, made by slacking 70 grams of commercial caustic lime and diluting with water to one liter. After the lime is added boil for 10 or 15 minutes; then allow to settle and draw off with a pipette about 50 c.c. of the clear solution, transfer to a beaker, and add a few drops of phenolphthaline. Then run in from a burette some of the sulphuric acid solution above described, until the last drop just discharges the color, and boil. If five or 10 minutes' boiling does not bring back any of the pink color, the caustic potash solution may be regarded as free from carbonates, and is ready to be proceeded with. If boiling does restore any of the pink color, the boiling with the lime must be continued, or fresh milk of lime added and boiling continued, until the solution is free from carbonates by above test. After carbonates are proven absent, filter the solution into the vessel in which it is to be kept for use, taking care to avoid exposure to the air as much as possible.

The two solutions thus prepared should be rendered homogeneous by stirring or shaking, and should then be allowed to stand until they are both of the temperature of about 70° F. This being accomplished, the strength of each in terms of the other must be known. For this purpose run from a burette 40 c.c. of the acid solution into a beaker, add a few drops of phenolphthaline, and then titrate with the caustic potash solution. Two or three tests should give the same figure within one or two drops. Preserve the figures thus obtained.

Now put the crucible containing the fused carbonate of soda before described into a beaker, add about 50 c.c. of distilled water, and allow to dissolve. Then add about 50 c.c. of the sulphuric acid solution above described and boil 15 minutes to remove carbon dioxide, taking care that there is no loss due to effervescence. After the boiling is finished titrate the excess of acid with the caustic potash solution, using phenolphthaline for the indicator. The relation of the acid and alkali being known as before described, it is easy to find the amount of the sulphuric acid solution corresponding to the carbonate of soda taken; but one point still remains uncertain—viz., whether the boiling has removed all the carbon dioxide. To decide this point, add to the solution which has just been titrated with the potash solution, and which the last drop of potash rendered pink, one drop of the acid solution, or enough to just completely discharge the color and boil again. If the color does not reappear on boiling, the figures already obtained may be regarded as satisfactory. If the color does reappear, run in one or two c.c. of the acid and boil again. The amount

of acid thus run in must be added to the 40 c.c. used at first. After boiling, say, five minutes more, titrate with the potash solution, noting how much of it is required to bring back the pink color, and adding this amount to the amount of potash solution previously used. Now test as before for the absence of carbon dioxide, and if it is proven not present, find the total number of c.c. of the sulphuric acid solution, which is equivalent to the carbonate of soda used. From this, as described below, the amount of sulphuric acid (H_2SO_4) in one c.c. of the acid solution may be obtained. But convenience in the subsequent use of the acid solution makes it desirable that each c.c. of it should contain a definite proportion of the molecular weight of sulphuric acid, say one-fourth or 0.0245 grams H_2SO_4. If sufficiently concentrated C. P. sulphuric acid has been used in making the solution to start with, the figure obtained as above will be larger than this, and, as shown in the calculations below, a certain amount of water must be added, which should be done, the solution being agitated by stirring or shaking, and then allowed to stand until the following day, when a new determination of its strength should be made by means of carbonate of soda, as above described. The figure thus obtained will show whether further addition of water is necessary. When all the water needed has been added, not less than two determinations of the strength of the acid should be made by means of carbonate of soda, as described above, which duplicates should show the value of 1 c.c. to be not less than 0.0244 gram, nor more than 0.0246 gram of sulphuric acid (H_2SO_4).

The standard acid having been obtained, it remains to make the caustic potash solution so that 1 c.c. equals 1 c.c. of the acid solution. For this purpose run, say, 40 c.c. of the standard acid into a beaker, and titrate with the caustic potash, using phenolphthaline as indicator. If fairly good caustic potash has been used in making the solution, this operation will show that water must be added. If the operation shows that the solution is too weak, it is better to throw it away and start again, using more of the potash per liter. The figure obtained enables, as is shown below, the amount of water that must be added to be calculated. This amount of water should be added, the solution agitated by stirring or shaking, and allowed to stand until the following day, when a new test should be made. The figure thus obtained will show whether further addition of water is necessary. After all the water has been added, not less than two tests should be made, and each of these should show that the two solutions are alike to within one-tenth of a c.c.

CALCULATIONS.

An example of all the calculations is given herewith.

I. *Standardizing the Sulphuric Acid.*—Suppose that 40 c.c. of the sulphuric acid as mixed requires 36.4 c.c. of the caustic potash as mixed to exactly neutralize it, this figure having been obtained by two or three closely agreeing tests. This means that 1 c.c. of the sulphuric acid solution is equal to (36.4 ÷ 40) 0.91 c.c. of the potash solution, and that 1 c.c. of the potash solution is equal to (40 ÷ 36.4) 1.0989 c.c. of the acid solution. Next suppose the fused carbonate of soda in the crucible weighs 0.9864 grams, and that 45 c.c. of the sulphuric acid as mixed are run into the solution of this carbonate of soda; also that after boiling it requires 9.2 c.c. of the potash solution to neutralize the excess of acid; also that it is found that the carbon dioxide is not quite all removed by the first boiling, and that 1 c.c. more of the acid is put in for a second boiling, and that after this second boiling it requires 0.4 c.c. of the potash solution to neutralize the excess of acid, and that test shows that the second boiling removed all the carbon dioxide. It is evident that 46 (45 + 1) c.c. of the acid have been used all together, and that 9.6 (9.2 + .4) c.c. of the potash solution have been used to neutralize the excess of acid. But 1 c.c. of the potash solution is equal to 1.0989 c.c. of the acid, or 9.6 c.c. of the potash solution are equal to (1.0989 × 9.6) 10.55 c.c. of the acid solution. Hence the amount of the acid solution used up by the 0.9864 gram of carbonate of soda is 35.45 (46 — 10.55) c.c. or 1 c.c. of the acid solution is equivalent to (0.9864 ÷ 35.45) 0.027825 gram carbonate of soda; but the ratio of the molecular weights of carbonate of soda (Na_2CO_3) to sulphuric acid (H_2SO_4) is as 106 to 98. Hence each c.c. of the sulphuric acid solution contains (106 : 98 : : 0.027825 : x) 0.025725 gram sulphuric acid. But, as previously stated, it is more convenient to have the acid and alkali solutions some even ratio of the molecular weight, and therefore a solution is wanted which contains (98 ÷ 4) 0.0245 gram of sulphuric acid per cubic centimeter. To obtain this, water must be added to the solution in question. The amount of this is found by the following ratio, $a : b : : x : c$, in which a represents the strength of the acid as determined, in this case 0.025725 gram, b the strength of acid desired, in this case 0.0245 gram, c the total volume of the solution we are working with, say, 15000 c.c., and x the volume of the solution after the water is added, which in the case supposed is (0.025725 × 15000 ÷ 0.0245) 15750, or (15750 — 15000) 750 c.c. of water must be added.

II. *Standardizing the Caustic Potash Solution.*—Suppose that it is found that 40 c.c. of the standard acid require 31.2 c.c. of caustic potash solution as made to exactly neutralize it. This means that water must be added, and the amount may be found by the proportion, $a : b : : x : c$, in which a represents the number of c.c. of standard acid used, in this case 40; b the number of c.c. of potash solution used, in this case 31.2; c the total volume of the solution we are working with, say, 15000 c.c., and x the volume of the solution after the water is added, which in the case supposed is (40 × 15000 ÷ 31.2) 19230, or (19230 — 15000) 4230 c.c. of water must be added. The reaction between sulphuric acid and caustic potash being represented by the equation $H_2SO_4 + (KOH)_2 = K_2SO_4 + (H_2O)_2$, or by weight 98 + 112.2 = 174.2 + 36, it must be remembered that, since 1 c.c. of each solution is the equivalent of the other, the actual amount of caustic potash (KOH) in each c.c. of the solution is (112.2 ÷ 4) 0.02805 gram—that is, if a solution containing any substance which reacts with sulphuric acid is so made that 1 c.c. equals 1 c.c. of the acid, the value of 1 c.c. of the solution in question may be found by writing the equation which expresses the reactions, together with the molecular weights, and dividing the molecular weight as given in the equation of the substance sought by the same figure that is required to give the known strength of the standard sulphuric acid. Further, the quotients thus obtained may be used interchangeably, according to the work in hand. Thus 1 c.c. of the standard sulphuric acid or 1 c.c. of the standard caustic potash is the equivalent of 1 c.c. of a solution containing 0.02355 gram of potash (K_2O), or of 0.020 gram of caustic soda (NaOH), or of 0.0155 gram of soda (Na_2O), or of 0.0265 gram of carbonate of soda.

III. *Caustic and Carbonated Alkali in Soap.*—Suppose 100 c.c. of the stearic acid solution requires 6 c c. of the standard potash solution to exactly neutralize it, and that after the soap has been dissolved in this it requires 4.3 c.c. of standard potash solution to exactly neutralize the excess of stearic acid. Also suppose that to the water solution of the material left on the filter from the first 5 grams, 5 c.c. of standard acid are added, and that after boiling 3.2 c.c. of standard potash are required to exactly neutralize the excess. It is clear that the total caustic and carbonated alkali in the 5 grams of soap under test are the equivalent of (6 — 4.3 = 2.7) + (5 — 3.2 = 1.8) 4.5 c.c. of standard potash solution. Next suppose that to the water solution of the material left on the filter from the second 5 grams 5 c.c of standard acid are added, and that after boiling it requires 2.9 c.c. of standard potash to exactly neutralize the excess. It is obvious that the carbonated alkali in the sample under test is equivalent to (5 — 2.9) 2.1 c.c. of the standard potash solution, also that the caustic alkali in the sample is equivalent to (4.5 — 2.1) 2.4 c.c. of the standard potash solution. But each c.c. of the standard potash solution is equivalent to 0.0265 gram of carbonate of soda, and to 0.020 gram of caustic soda. Hence the 5 grams of soap contains 0.05565 gram of carbonate of soda and 0.048 gram of caustic soda or (5 : 100 : : 0.05565 : x) 1.113 per cent. of carbonate and (5 : 100 : : 0.048 : x) 0.96 per cent. of caustic soda.

Notes and precautions on this method will follow.

PROCEEDINGS OF SOCIETIES.

Boston Society of Civil Engineers.—A regular meeting was held on February 15. Mr. W. E. McClintock gave an account of the work of the Massachusetts Highway Commission, illustrated by lantern views showing the condition of the roads throughout the State. Mr. E. W. Howe showed by lantern views the kind of roads built by the Boston Park Department, and Mr. E. F. Foss gave some of the streets in Chicago and Buffalo. A general discussion on road construction followed.

The New York Railroad Club held its regular March meeting on the evening of the 16th. Mr. Dixon, of the Rogers Locomotive Works, read a paper on the Locomotive Boiler, which was followed by a discussion turning chiefly on the methods of staying the fire-box, and especially the crown-sheet. In the course of the discussion it was stated that the chief trouble with the Belpaire form of boiler lay in the leakage which was apt to occur between the flat, top sheet over the fire-box and the shell, owing to the unequal expansions which occur.

The Engineers' Club of St. Louis held its 378th meeting on February 15. The paper of the evening was by Mr. O. W. Ferguson, on Methods and Results in Precise Leveling. Mr. Ferguson described the instrument used, the methods employed, and the causes of error. He cited results from different surveys, exhibited profiles, forms of note-books employed, and speed of working. He gave the cost of precise leveling at $18 to $21 per mile for field expenses. Cited a polygon of 4,000 miles in length, extending from Chicago to New York, Biloxi, New Orleans, back to Chicago, that closed with an error of 1 ft. Stated that bench marks had been established every 1½ miles along the Missouri River from St. Louis to Sioux City by the Missouri River Commission.

Engineers' Club of Philadelphia.—At the regular meeting on March 4 Professor Joseph T. Rothrock delivered an address on Wood Structure in its Relation to Mechanical Purposes, explaining the effect of cellular and woody fibre upon the strength and durability of wood, and pointing out the predominance of one or the other kinds of growth in different trees, and their consequent adaptability to different purposes.

He explained that while the so-called annual rings might be used in counting the life of a tree, in most cases this was not an invariable rule, and one might be misled in following it in some cases.

He closed by showing the distribution of the timber area in the State of Pennsylvania, and called attention to the necessity for better supervision for its protection.

Engineers' Club of Cincinnati.—At the February meeting Mr. Oswald Dietz read a paper on the Peculiarities of Numbers, which was an explanation of the law or rule governing the fact that the square of any number cannot have as its last figure 2, 3, 7, or 8, and that the bi-square of every number which is not a multiple of 5 can have as its last figure only 1 or 6.

This was followed by one on a proposed plan for disposal of overhead wires in cities by Colonel Latham Anderson. The plan proposed was that of placing the wires directly over the sidewalks at a height of 18 ft. on suitable supports extending from poles on the curb line, about 80 ft. apart, to the buildings, and preventing the falling of the wires to the sidewalk in case of breakage by a mesh of wires with ground connection through the poles. Another plan would be the placing of the wires directly under the sidewalks in areaways between the curb and the house line. Sewer, water, and gas-pipes could also be so placed.

Engineers' Club of St. Louis.—The Club met on March 15, and Mr. Robert Moore read a paper on Some Notes on European Travel. By means of a chart the mileage, cost, receipts, expenses, etc., of the railroads of the world was clearly shown. The cost per mile was highest in Great Britain—$212,220—and lowest in Sweden—$29,100. The interest on capital was: 5.2 per cent. in India; 5.1 per cent in Germany; 4.1 per cent. in Great Britain; 3.1 per cent. in the United States, and 1.7 per cent. in Canada. The track and chair fastenings were illustrated by a number of photographs. This method gave a steadier track than the usual American method of using spikes only. A number of fine photographs showed the English engines and cars. The high cost of the English roads was shown to be largely due to the expensive bridges, terminals, etc. A marked feature of the English roads was the rapid handling and delivery of freight—freight received at London during the afternoon being delivered at any point the next morning. In Switzerland and Germany the metal ties are being largely introduced.

PERSONALS.

Mr. Alonzo Dolbeer has been appointed Master Mechanic of the Lehigh Valley Railroad, at Buffalo.

Mr. R. K. Mulcahy has been appointed Superintendent of the Oregon Pacific, with headquarters at Corrallis, Ore.

Mr. C. M. Lawler, Assistant General Manager of the Philadelphia & Reading, has been made General Superintendent of the main line.

Mr. William Renshaw has been promoted to be Superintendent of Machinery of the Illinois Central, succeeding Mr. Henry Schlacks. Mr. Renshaw has risen on the Illinois Central from a machinist. He was successively Foreman, Master Mechanic, and Assistant Superintendent of Machinery.

Mr. E. G. Russell has been appointed Superintendent of the Rome, Watertown & Ogdensburg, with headquarters at Watertown, N. Y. Mr. Russell was for several years Superintendent of the Illinois Central, and attracted considerable attention by the fight he carried on with the striking switchmen of that road at Chicago. He is a man of strong personality, and does not tolerate any interference with his authority.

Mr. Theodore N. Ely, formerly General Superintendent of Motive Power of the Pennsylvania Railroad, with headquarters at Altoona, has been appointed Director of Motive Power of the Pennsylvania lines, with his office at Philadelphia. F. D. Cassanave, heretofore Superintendent of Motive Power of the northwest system of the Pennsylvania Company, with office at Fort Wayne, has been appointed Mr. Ely's successor. G. L. Potter is promoted to the position vacated by Mr. Cassanave. W. W. Atterbury succeeds Mr. Potter as Master Mechanic of the Fort Wayne lines.

OBITUARIES.

Mr. Edward G. Gilbert, President of the Gilbert Car Manufacturing Company, died suddenly March 7 at his home in Troy, N. Y., aged 46 years.

Mr. C. H. Kendrick, who was General Ticket Agent of the New York Central from 1852-87, died at Elkhart, Ind., on the night of March 3, at the age of 70. Mr. Kendrick was born in Nashua, N. H., and his first railroad service was on the Nashua & Lowell. Before the consolidation of the New York Central and the Hudson River he was on the latter. From 1869-77 he was General Passenger Agent in addition to his other duties. After 1877 his title was Auditor of Ticket Accounts.

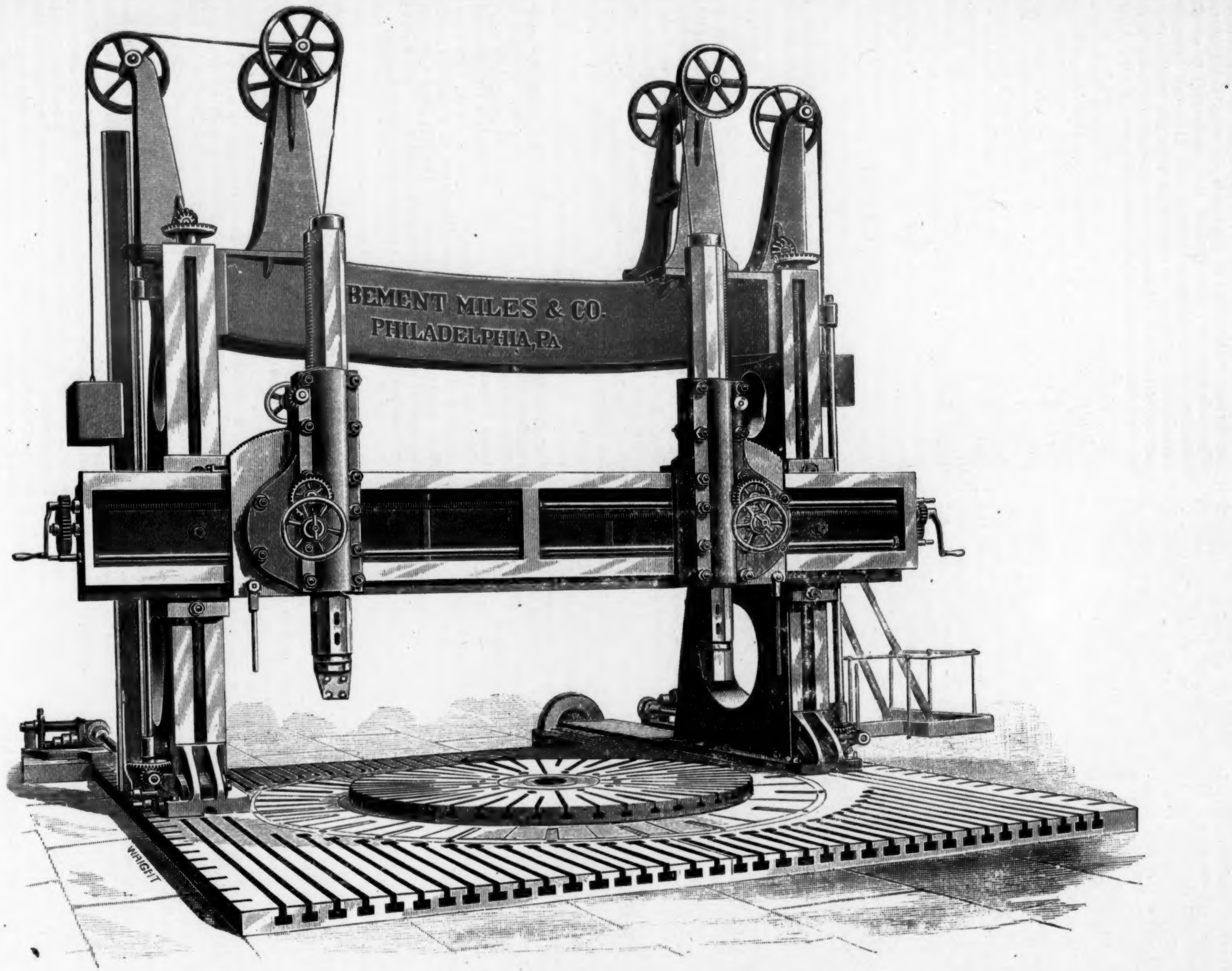
Colonel Richard Vose, the well-known manufacturer of car springs, died at Nyack, N. Y., February 25. He was born at Whitesboro, N. Y., in 1830, and when 24 years old was appointed Superintendent of the Manufacturing Department of the Metallic Car Spring Company, of New York. In 1868 he established the firm of Vose, Dinsmore & Company, and in 1876 its business was transferred to the National Car Spring Company, of whom he was elected President. He invented improvements in car springs and amassed a large fortune.

SOME CURRENT NOTES.

A Krupp Extension.—The Krupp firm keeps extending at a considerable rate. Their negotiations with Li Hang Tshang have now ended in an agreement, according to which the firm shall erect a large foundry and rolling mill at Kaiphing. These works will supply the railway material for the line from Tientsin to Shanghai Kuan and the contemplated extension to Nirin.

Forests Required to Supply Ties.—An estimate has been made that 1,000,000 acres of forest are required for the annual supply of wooden sleepers for European railways. These forests are properly managed so as to yield a steady return, while nothing of the kind can be said of American forests. This explains why German foresters are interested in watching the progress of forest destruction in America, where it is now merely a question of 10 or 15 years before a timber famine must occur, which will greatly enhance the value of European forests.—*Nature.*

Coal and the Channel Tunnel.—The engineer of the Channel Tunnel Company, Limited, makes the following statement in his recent report on the Trial Boring for Coal: "The coal boring has now reached a depth of 2,228 ft., including 1,071 ft. of coal measures in which nine workable seams have been found, containing altogether 20 ft. in thickness of good bituminous coal. This coal is suitable for gas making and household purposes. The deepest seam, 4 ft. in thickness, was met with at 2,222 ft. from the surface." So it looks as though this company may get something out of its coal mines, even if its tunnel comes to nothing.

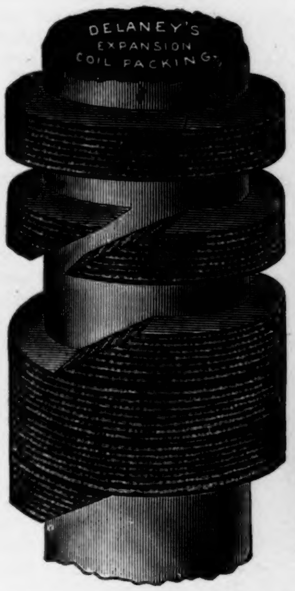


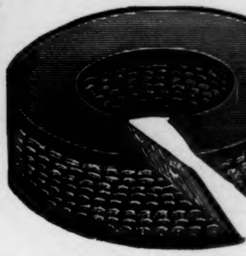
LARGE BORING MILL FOR ROBERT POOLE & SON CO.

Fire Protection at Cleveland.—A novel system of fire protection is in use in Cleveland, O., which has proved quite successful. Four 6-in. mains are laid from Cuyahoga River to the business streets of the city, the distance being from 700 ft. to 1,000 ft. The mains are provided at intervals with ordinary fire hydrants, but are normally quite empty, as they are laid with a slope toward the river, into which they empty themselves. In a case of fire, the city fireboat is run to the river end of the mains, with which one of its nozzles is connected. The pumping engines in the boat are capable of putting on a pressure of 200 lbs. to 250 lbs. per square inch, so that a good pressure is available at the hydrants.

Electric Power for Seattle.—About fifteen miles from Seattle, Wash., the Snoqualmie Falls are formed by the descent of the Snoqualmie River over a precipice 268 ft. high into a gorge which broadens out quite rapidly into a fertile valley.

It is proposed by some wealthy capitalists to run an electric cable from the falls to Seattle. A series of turbine wheels will be placed at the foot of the falls, to which the water will be conducted by flumes, and they will transmit the power by means of shafting to an immense electric plant, where it will be transformed into a current and started over the cable to Seattle for distribution among the saw mills, street railroads, and all the different industries of the city. The cable will be laid under ground as nearly in a straight line as possible, only diverging to avoid two marshes and any inaccessible mountains which may be encountered, and passing under Lakes Sammamish and Washington, direct to the eastern limits of the city.





The initial plant will generate 5,000 H.P., and, the projectors say, will be in operation within six months. The capacity of the falls, of course, varies according to the volume of water in the river, but at the lowest in midsummer it runs into the hundreds of thousands of horse-power.

Manufactures.

ROBERT POOLE & SON COMPANY'S LARGE BORING MILL.

In the February number of the American Engineer we published an illustration and description of the shops of the Robert Poole & Son Company, in Baltimore, Md. Reference was then made to a large boring mill, which was indistinctly shown on the right-hand side in the view of the erecting shop. We give with this number an engraving of this mill, of which only the upper portion is shown. The driving gear, which is below the floor, is not shown. This part of the machine was made in the works of the Robert Poole & Son Company. The upper part, which is shown in our illustration, was made by Messrs. Bement, Miles & Company, of Philadelphia, to whom we are indebted for the following description :

LARGE UPRIGHT BORING MACHINE.

When the uprights are in their forward position, as shown in the cut, the total swing of the machine is 16 ft. 2 in. This can be increased to 24½ ft. or any intermediate distance by drawing the uprights backward upon the bed plate, for which purpose a power attachment is provided. The diameter of the table above the floor plate is 10 ft., but below the plate it is extended to 14½ ft., and carries a large spur gear of the same diameter, through which it receives its rotating motion. The table spindle is fitted with adjustable bearings for taking up wear. At the lower end of the spindle an arrangement is provided, if required, for raising it entirely off its upper horizontal bearing. The bed plate is 20 ft. wide and 34½ ft. long from front to back. Its upper surface is slotted, to receive any additional stands or tool posts that may be required. The cross-slide has a vertical depth of 37 in., and its length is sufficient for turning conveniently the largest diameters that the machine will receive. It is raised and lowered by a convenient power attachment to a height of 10 ft. above the table. The saddles are traversed independently upon the cross-slide, by hand or power, from either end of the slide, and also by special gearing arranged upon each saddle. The steel cutter-bars are counterweighted independently, and so arranged that the weight of the cutter-bars, as well as that of the counterweights themselves, does not come upon the cross-slide, but is supported upon the main framing. The cutter-bars are held and guided in long bearings at the inner edge of each saddle, so that they may be brought very close together when required. They can be swivelled to any angle by worm gear and screw, for boring or turning tapered. Their traverse motion at any angle is 6 ft., or more if required. They can be moved by hand or power—that is, either by the apparatus upon the saddle itself or by the crank handles and gears at the ends of the cross-slides. The driving gear—arranged for 20 varying speeds—is placed at the right hand side of the machine. The feeding motions for the saddles and cutter-bars are obtained by means of friction disks, which admit of an infinite gradation from 0 to 1 in. in width per revolution of table. The amount of feed for each bar can be varied, stopped, or started without any reference whatever to that of the other bar.

This machine enables the Robert Poole & Son Company to do a class of heavy work which few or no other establishments in the country are prepared to undertake. It is also an excellent example of the heavy machine tools the enterprising Philadelphia firm is producing.

DELANEY'S COIL AND RING PACKING AND GASKETS.

The accompanying engravings represent the sectional ring and coil packing for piston and pump-rods, valve-stems, etc.

These are made by a process which, it is claimed, affords perfect lubrication, and it expands in such a way as to relieve the rods from all undue pressure. It is said to be extremely durable, and owing to the materials used and the method of manufacture, it is never burned or hardened while in use.

The lower engraving represents the man-hole gaskets of the same makers. These are said to form especially durable steam and water-tight joints, being made to stand a pressure of 300 lbs. These goods are manufactured by Messrs. H. J. Delaney & Company, Milwaukee, Wis.

STARRETT'S NEW TOOLS.

The accompanying engravings illustrate some new tools made by L. S. Starrett, of Athol, Mass. Fig. 1 is a universal surface gauge. It has the following improved features—viz., a joint at the base which allows the spindle and scriber to be moved back and forth and placed in any position from upright to horizontal to reach over, back of and under work that could not be got at with old-style gauges, while by inclining the spindle over the work its scope for long reach is increased.

The fine adjustment is nicely obtained by the knurled screw in the rocking bracket at the base acting against a stiff spring under the opposite end, while the joint above with the spindle may be set and rigidly held in any position desired. Two pins through the base, frictionally held, may be pushed

down by slight pressure to form a bearing to work from the edge of, or in the slots of the planer bed for lining up work, while the weight of the gauge against the bed with a little

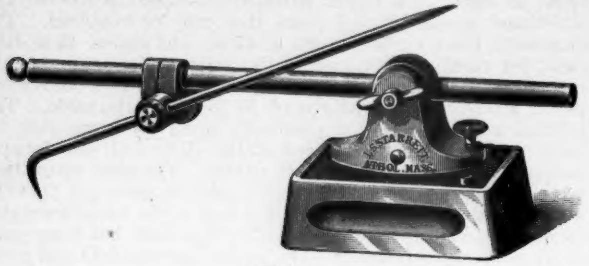


Fig. 1.

pressure is sufficient to push them back. Grooves around these pins, against which a pointed spring plunger presses, insure their being held in place either up or down. Concaved depressions milled in the sides of the base make it convenient for thumb and finger to grasp.

Fig. 2 is a similar tool of a smaller size and made on the same principle as the one shown in fig. 1. The base is steel nicely finished and *case-hardened*, with depressions milled in the sides for the thumb and finger to grasp. The top side of it is slotted, and the rocking bracket is pivoted in the same. There is a stiff spring under one end of the bracket and a knurled adjusting screw in the other; the spindle jointed to this may be set and rigidly held in any position from vertical to horizontal, and the scriber placed in position to be used below its base for depth gauge, or (with bent end down) a scribing gauge. It weighs but 11 oz., and is 5 in. high, and, folding the spindle (which is 4 in. long) horizontally over the base, it may be packed in $1\frac{5}{8}$ in. $\times$ $1\frac{1}{2}$ $\times$ 4 in. space in the tool chest.

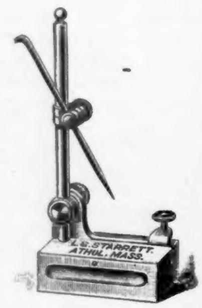


Fig. 2.

THE MAXON JACK.

We illustrate herewith a convenient form of locomotive jack, which is made by the McSherry Manufacturing Company, of Dayton, O. It has a height of 12 in. with a 6 in. lift, a capacity of 20 tons, and weighs 27 lbs. The screw is of steel 2 in. in diameter, and runs in an iron nut. The ratchet box, head and stand are of malleable iron.

General Notes.

At a recent fire of a cotton-press in Baltimore, Md., most efficient service was done by the fire-boat *Cataract*, which was built two years ago, and considerable attention was attracted to her by the work performed. She was built from the designs and under the superintendence of William Cowles, Constructing Engineer and Naval Architect, who is also President of the Cowles Engineering Company, which latter company furnished the Cowles water-tube boilers which supplies the steam for the engines and pumps of the *Cataract*.

The Riehle Brothers Testing Machine Company announce that beginning April 1 Mr. J. R. Matlack, Jr., will act as its representative at the World's Columbian Exposition, Chicago, and can be found, previous to the opening of the Exposition, at the Rookery Building, Chicago.

Staten Island Industries.—Messrs. J. B. King & Company, of New Brighton, are now putting into their extensive plaster mill a 1,000-H.P. condensing engine, built for them by Messrs. Watts & Campbell, of Newark, N. J. They have also added to their present boilers one large steel boiler, 200 H.P., built at the Starin Ship & Iron Works, Port Richmond.

The boilers, gas-burning furnaces, chimney and the entire system of underground flues connecting them were constructed under the designs and supervision of Mr. R. K. McMurray, a long-time resident of West Brighton, and Chief Inspector of the Hartford Steam Boiler Inspection and Insurance Company, of Hartford, Conn. Mr. McMurray also designed the large chimney, as well as all of the boilers of the Clark Thread Works, at Newark and East Newark.

The Sargent Company.—The name of the Congdon Brake Shoe Company has been changed to "The Sargent Company," and the business established under the former name, in 1876, confined at first to the introduction of the Congdon brake shoe, and developed since into a general brake shoe, iron and steel castings business, will hereafter be carried on under the latter name.

The Magnesia Sectional Covering Co., of 58 Warren Street, are issuing a set of very handsome steel engravings of the new United States cruisers, upon which their magnesia covering is used. The cards are elegantly printed, and are souvenirs well worthy of presentation.

The Johnson Railroad Signal Company have just closed a contract with the Chicago & Northern Pacific Railroad Company, E. J. Pearson Principal Assistant Engineer, for interlocking plant at Harvey, at the crossing of the Chicago Central, Chicago & Grand Trunk and Illinois Central railroads, 50 working levers.

Electric Car-Heater.—The Consolidated Car-Heating Company have brought out a new electric heater, of which they have sent us an elaborate description. Want of room has prevented its publication in this number of The American Engineer, but we expect to refer to it again in our next issue.

The Oliver Colborne Manufacturing Company, 59 East Indiana Street, Chicago, are working their force full time, keeping pace with the demand for the Tuttle gas-engine. This firm have recently fitted up their office in becoming style and greatly enlarged the output of their plant.

J. C. Drake Machine Works, Morgan and Jackson streets, Chicago, have been unusually busy in the manufacture of their clay crushers and brick-making machines. They are now some two months behind orders, and this fact suggests the prediction that brick manufacturers expect an unusually large demand for building material during the coming season around and in Chicago.

THE MAXON JACK.

The Diamond Machine Company, makers of grinding and polishing machinery, of Providence, R. I., has adopted for use in its exhibit at the World's Columbian Fair an illuminated sign, which will be of fine stained glass and wholly new in method of construction, for, in place of the unstable mounting of lead with the unsightly iron crossbars heretofore used, the glass is set in a durable cement between copper; the latter is "whole," as the spaces filled by the glass are cut out. Desirable and artistic effects are thus gained by the very varying lines or "masses" of copper never before attained under the old method. This new patented way of setting stained glass is owned by the Metallic Setting Company of Providence.

Raymond Brothers Impact Pulverizer Manufacturing Company, 271 South Jefferson Street, have just sold the National Oil & Paint Company a pulverizer to crush ore, from which they manufacture paint which the Union Pacific Railway use altogether. They have also put in a complete paint plant for the Chicago & Northwestern Railway at their 40th Street shops, this city. They report business exceedingly active. Raymond Brothers have just patented a new windmill, which besides from being lighter than any other style of wind-mill now manufactured, has less joints to break and the gearing is unexposed.

The Link-Belt Machinery Company recently closed a very large contract with Mr. J. C. Henderson, Engineer of the Milwaukee Street Railway Company, for a very extensive system of coal and ash handling machinery. The coal will be taken from wagons or barges in the river, at opposite end of building, and conveyed from either point to a system of coal bunkers, extending from first floor to ceiling of third

floor. From these bunkers the coal may be drawn to any one of the nine boilers located on either the first or second floor. The ash device is designed to receive from any one of the 18 boilers, delivering them to either one or two storage bins, from which they may be drawn into carts or barges to be carried away. This will make the most extensive system of coal and ash handling machinery erected in the West, and is in keeping with the magnificent new power plant of this company in Milwaukee.

The Ammonia Motor Again.—The Railway Ammonia Motor Company, which has offices in the Drexel Building, gave an exhibition of its system of running street cars recently. The motor this company uses was invented by P. J. McMahon, formerly a chief engineer in the navy.

The ammonia is first evaporated, and after the water has thus been removed from it, it is passed through a coil of pipes, over which cold water is sprayed. It is thus reduced to a liquid called anhydrous ammonia, which is collected in a big tank, from which it is drawn into a smaller tank on the car. This car tank is surrounded with an outer box containing hot water.

To generate the power the anhydrous ammonia is heated to about 80°, and as the liquid will boil in the air at 38½° below zero, the heat develops a pressure of 150 lbs. This pressure works a piston in the same way as steam.

Enough ammonia can be stored on an ordinary car to run it for seventy miles over an average road. When one charge is exhausted another can be put in very quickly. Mr. McMahon reckoned the cost of running a car with his system at one cent a mile.

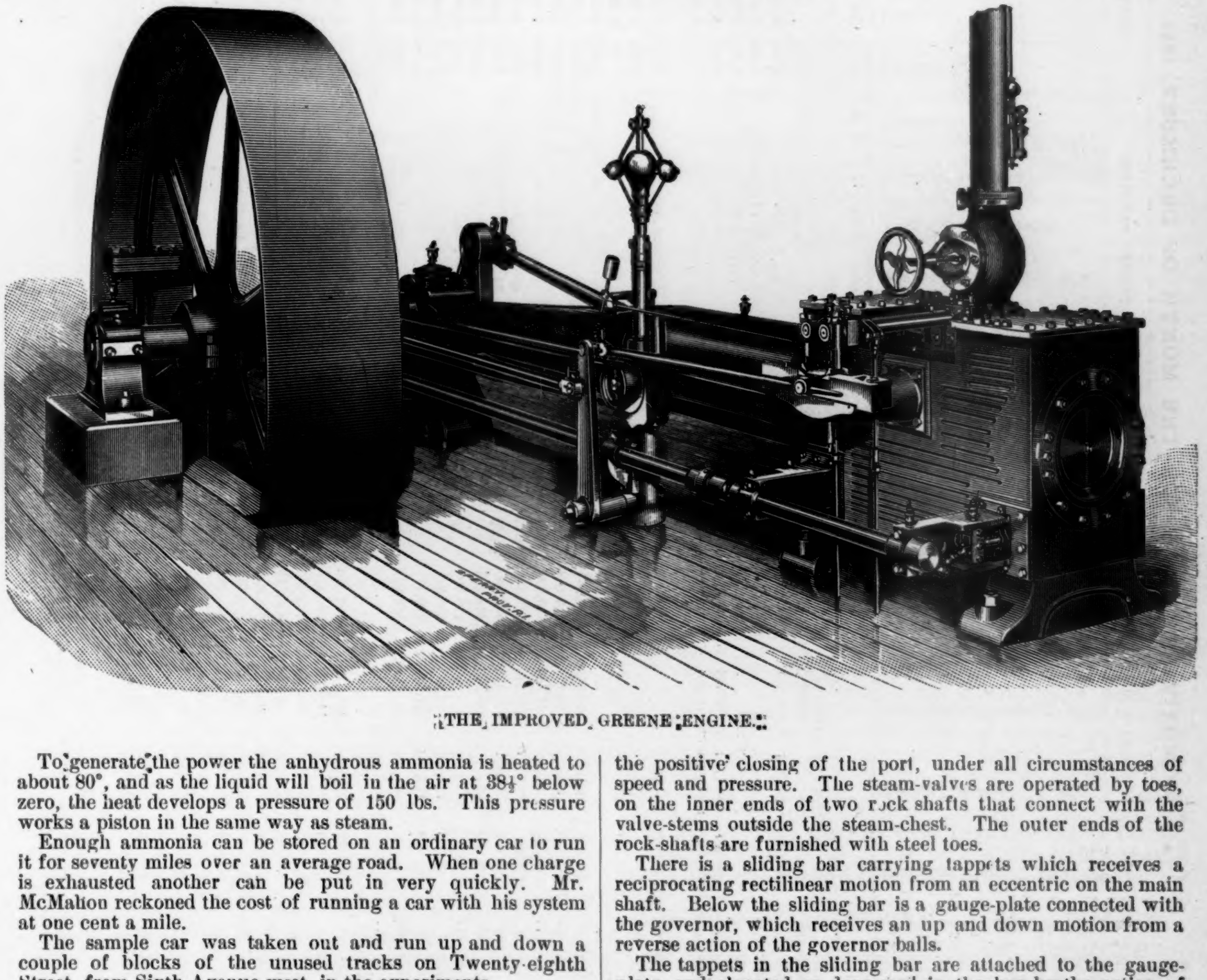
The sample car was taken out and run up and down a couple of blocks of the unused tracks on Twenty-eighth Street, from Sixth Avenue west, in the experiments.

A Naphtha Cab.—A cab propelled by a petroleum-naphtha motor has been tried recently in Berlin. It is not a new invention, but was already seen at the Munich Exhibition in 1888. The firm which brought it out—the gas motor works of Benz & Company, in Mannheim—assert that they have made so many improvements that the cab is quite fit for practical use. The motor cabs are three-wheeled, and can carry only two persons, the driver included. Behind the seat is a sort of boot, which contains a petroleum-naphtha motor of nearly 2 H.P. The explosive mixture of petroleum, gas, and air, which is the moving power, is ignited by an electric apparatus. The inventors assert that on a good road a speed of about eleven miles an hour can be obtained. The price of such a cab is £250. It looks like a large two-seated bath chair.

THE IMPROVED GREENE ENGINE.

Our illustration represents a perspective view of the new improved Greene automatic cut-off engine, which is as it is built by the Providence Steam-Engine Company, of Providence, R. I.

The bed plate is of the girder pattern, symmetical in appearance, and of ample strength. The main journal-boxes are made in four pieces, and provided with set screws and check nuts, which permit of convenient and accurate adjustment. The governor is of the Porter pattern, and is driven by a flat belt from the main shaft. The valve-gear is detachable, and is so controlled by the governor that the cutting off may be effected from zero to three-quarters of the entire stroke. The valves are four in number—two steam and two exhaust—and are of the flat-slide pattern. The power which moves them is applied parallel to and in line with their seats, so that they cannot rock or twist—thus obviating the tendency to wear unevenly. The steam-valves when tripped are shut by a combined action of a weight and the pressure of the steam on the large valve-stems, thereby insuring a quick cut-off, and



THE IMPROVED GREENE ENGINE.

the positive closing of the port, under all circumstances of speed and pressure. The steam-valves are operated by toes, on the inner ends of two rock shafts that connect with the valve-stems outside the steam-chest. The outer ends of the rock-shafts are furnished with steel toes.

There is a sliding bar carrying tappets which receives a reciprocating rectilinear motion from an eccentric on the main shaft. Below the sliding bar is a gauge-plate connected with the governor, which receives an up and down motion from a reverse action of the governor balls.

The tappets in the sliding bar are attached to the gauge-plate, and elevated or depressed in the bar by the action of the governor. As the sliding bar moves in the direction of the arrow, one of the tappets is brought in contact with the inner face of the toe on the rock-lever, causing it to turn on its axis, thereby opening the steam-valve at one end of the cylinder. At the same moment the other tappet comes in contact with the outer face of the other toe, and as the surfaces are beveled, the toe is forced up into the socket until the tappet passes under, when it drops by gravity alone into its original position, to be operated upon in its turn, when the motion of the sliding bar is reversed.

As a result of this motion, the tappets always give the valves the same lead, and as the bar moves in a straight line, while the toe describes the arc of a circle, the tappet will pass by and liberate the toe, which is brought back to its original position by a weight and the steam pressure on the large valve-

LOCOMOTIVE RETURNS FOR THE MONTH OF DECEMBER, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama, Great Southern																									
Alabama & Vicksburg																									
Atchison, Topeka & Santa Fé	834	739			387,071	2,289,931	3,099						91.91			5.65	7.54	0.26	6.17	6.87	1.54	22.03			1.58
Canadian Pacific	610		484,647	745,154	411,019	1,640,820	3,084						78.30			4.08	13.21	0.42		5 71	1.41	24.83			3.34
Chic., Burlington & Quincy	532					1,939,414	3,646	4.89	16.98				93.72			5.38	6.54	0.25	0.36	6.75		19.28			1.40
Chic., Milwaukee & St. Paul	820					2,781,026							79.23			3.96	8.10	0.27		6.81		19.14			2.00
Chic., Rock Island & Pacific	552		560,666	970,112	433,536	1,964,314	3,558						68.39			2.85	6.68	0.24	2.85	6.00	0.42	19.04			1.68
Chicago & Northwestern	888		707,331	1,484,893	741,916	2,934,120	3,304						93.62			3.51	9.12	0.36		6.36	0.84	20.19			1.98
Cincinnati Southern																									
Cumberland & Penn*	22	22	5,699	34,059		39,758	1,807						91.33			7.80	0.40		5.10		2.10	15.40			
Delaware, Lackawanna & W. Main L.	208	192				651,036	3,390						102.66			3.26	7.96	0.42		5.85					
Morris & Essex Division			174,738	243,426	12,597	430,761	2,726						72.91			5.16	11.29	0.39		6.27		23.11			3.07
Hannibal & St. Joseph	74					284,811	4,011	5.56	16.15				96.80	14.18	7.95	4.63	6.71	0.14	0.46	6.52		18.46			1.45
Kansas City, F. S. & Memphis	150		96,294	269,505	133,236	499,035	3,327						71.42			3.07	5.85	0.25	0.44	7.39		17.00			1.50
Kan. City, Mem. & Birm	41	37	37,093	63,923	14,090	115,108	3,111						65.89			3.38	3.79	0.24	0.35	6.88		14.64			1.10
Kan. City, St. Jo. & Council Bluffs		43	55,492	43,542	44,865	143,899	3,346	4.90	18.90				71.55	14.23	5.76	5.00	7.17	0.15	0.65	6.67		19.66			2.05
Lake Shore & Mich. Southern	584		446,617	885,097	589,840	1,921,554	3,273			68.65	91.40	40.81	71.81			3.71	5.60	0.12	0.06	6.96	0.19	16.64			1.56
Louisville & Nashville		350†	43[illegible],133	789,557	458,995	1,683,685	3,673	5.15	16.48	66.75	116.81	54.66	87.73	13.01	7.19	3.89	6.96	0.25	0.43	6.11	1.56	19.20	3.27	1.41	1.60
Manhattan Elevated		291	786,986		59,278	846,254							49.50			2.70	9.80	0.30		8.80		21.60			3.96
Mexican Central‡	146	114				416,208							76.27			3.88	17.01	0.48	0.20	5 29	0.84	27.68			5.43
Mil., L. S. & Western	112		78,768	144,151	72,355	295,274							86.58			3.70	12.05	0.24		6.30	0.94	23.23			2.80
Minn., St. Paul & Sault Ste. Marie			61,588	173,733	37,816	273,147		4.92	17.08				88.31			5.02	15.57	0.24		6.78		27.61		2.30	3.37
Missouri Pacific	339	303				1,152,675	3,801	4.55	16.96				95.14			5.67	6.90		1.68	6.51	1.57	22.33	4.16	1.64	1.43
Mobile & Ohio																									
N. O. and Northeastern																									
N. Y., Lake Erie & Western	618		462,007	966,941	293,678	1,722,626	3,160	4.50	22.08	89.01	144.9	78.00		19.08	6.07	4.45	8.10	0.37	2.42	7.33	1.14	23.81		1.79	1.87
N. Y., Pennsylvania & Ohio	253		135,775	447,793	148,907	732,475	3,450	5.40	17.04	78.01	124.2	73.90		14.03	7.01	4.03	5.91	0.31	2.15	6.87	1.09	20.36		1.74	1.12
Norfolk & Western, Gen. East. Div.†			100,236	269,557	53,870	423,663	2,922	4.07	18.09				106.38			8.50	3 80	0.70				13.00			
General Western Division†			70,751	236,206	25,719	332,676	2 683	4.06	15.00				131.57			16.60	4.60	0.80				22.00			
Ohio and Mississippi	109		139,382	140,298	87.173	366,853	3.365						88.88			3.52	3.20	0.21	1.63	5.48	1.41	16.00			0.81
Old Colony		224	365,772	223,758	33,457	622,987	2,781						64.18			3.36	12.03	0.62		6.76	0.81	23.58			3.75
Philadelphia & Reading			479,393	877,450	604,652	1,961,495							80.60			4.68	5.11	0.29		5.91	0.39	16.38			
Southern Pacific, Pacific System																									
Union Pacific	992		727,217	1,544,449	521,311	2,792,977	3,768	5.43	16.36				101.88			7.35	8.98	0.42	0.93	8.22	1.08	26.98	4.49	2.04	1.74
Vicksburg, S. & P.																									
Wabash	424	368	409,899	717,264	312,109	1,439,272	3,911			75.47	113.70	57.19	95.38	14.09	6.98	3.61	5.13	0.30		6.17	0.88	16.04	2.94	1.14	1.13
Wisconsin Central			126,839	234,986	60,129	421,954										4.58	11.38	0.28		7.20		23.44			2.35

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

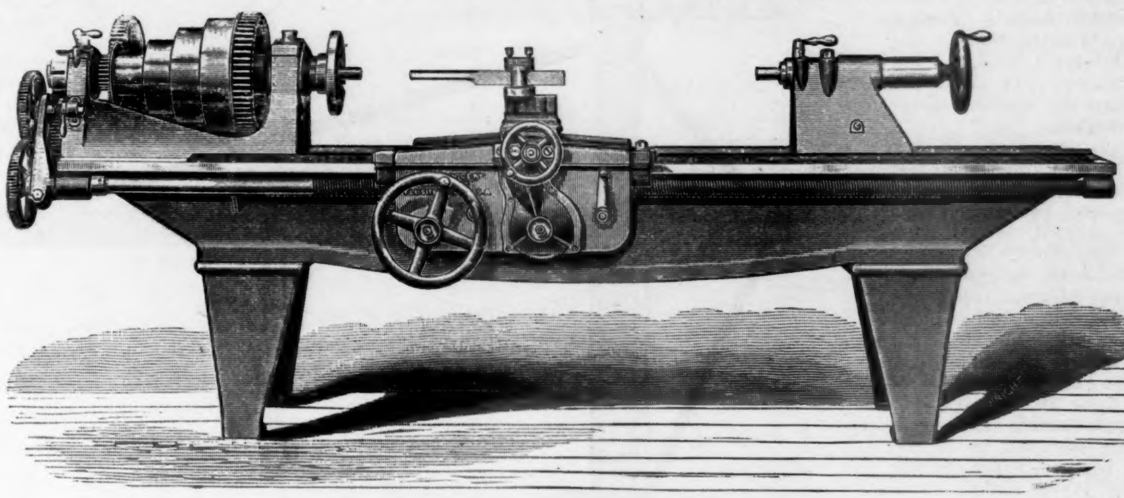
‡ Report for November, 1892.

stem, which thus closes the valve and cuts off the steam. The liberation of the toe will take place sooner or later, according to the elevation of the tappets—that is, the lower the tappets are, the sooner the toes will be liberated, and *vice versa*. By the elevation or depression of the gauge-plate, the period of closing the valves is changed, while the period of opening them remains the same. The adjustment of the gauge-plate is effected directly by the governor.

Both the exhaust-valves and seats are convenient of access, and removable from the outsider of cylinder. The valves receive their motion from a separate eccentric, thus allowing of easy adjustment, without interference with the steam-valve mechanism. All the connections are on the outside, are few in number, and have ample bearing surfaces, insuring freedom from rapid wear and derangement.

A safety stop-motion is combined with the governor, preventing the admission of steam should the governor belt run off or break.

The cross-head gibs are directly opposite the center of pin, thus avoiding any cross strain upon the piston-rod. The steam-ports are large, thus insuring the full pressure of steam to the point of cut-off. The engine is extremely sensitive to the action of the governor, and all parts are well proportioned, made of the best material, accurately fitted, and highly finished.



BOGERT'S IMPROVED 20-INCH ENGINE LATHE.

BOGERT'S IMPROVED 20-IN. ENGINE LATHE.

THE lathe illustrated is one made by John L. Bogert, of Flushing, N. Y., and has a swing over the top of the cross-slide of 14¼ in., with length of bed of 10 ft. 3 in. The head stock has carefully fitted, adjustable boxes lined with the best phosphorized Babbitt metal. The front bearing is 3½ in. in diameter by 5⅝ in. long, and its cap is held down and adjusted by four ¾-in. bolts. The live spindle is of very hard crucible steel, and has, unless otherwise ordered, a 1¼ in. hole through its axis, carries a four-step cone for a 3½ in. double belt, and a front gear 14¾ in. in diameter. Its end thrust is taken upon hardened tool steel collars with sides ground perfectly parallel. The ratio of the back gearing is 12 to 1, which, taken in connection with the diameters chosen for the corresponding steps of the overhead and main cones, makes the speed of rotation of the live spindle decrease in exact geometrical ratio from the fastest to the slowest. A very accessible rocking device on the back end of the head stock enables the direction of the feed to be instantly reversed without disturbing the change gears. The lead screw is 1$\frac{1}{16}$ in. in diameter, it cuts three threads to the inch, and is made as accurate in every way as is practically possible. The usual variety of threads from one to 16 per inch can be cut with the change gears without compounding. The thread of the lead screw is used only for screw cutting, the longitudinal and cross feeds being driven by means of a large key way or spline. The half nuts are opened and closed by one-third of a revolution of two single-threaded screws of large diameter, and cannot fly open under any condition of feed strain. Both power feeds are frictional, and their engagement being by screws, slipping can at any time be prevented. All gearing of any description is cut from the solid, and the feed worm-gears are made of phosphor-bronze. The carriage is 33 in. long, gibbed for its whole length along the back shear, and at each end of the apron along the front shear. One of these latter gibbs is used to clamp the carriage when cross feeding. It is important to note the fact that the cross feed is made as coarse as the longitudinal feed, so that the feed-gearing rarely needs to be disturbed. The cross-slide, 20¾ in. long, is fitted with one of Bogert's patent double screw tool posts. A telescopic slide by its movement protects the cross-feed screw from chips in any position of the tool. The tail stock may be set over, to line the centers, and is clamped to the bed by two ⅞-in. bolts. The tail stock spindle is 2⅝ in. in diameter and 16½ in. long. The center rest will admit work from ⅝ in. to 9 in. in diameter without change of jaws. The follow rest is made either with adjustable jaws or with a split hole, to clamp bushings. Bogert's improved friction clutches and Bogert's improved method of oiling loose pulleys are features of the counter shaft. Counter-shaft pulleys, 15 in. in diameter and 4 in. face, should make from 160 to 180 revolutions per minute; the backing pulley should be run at least as fast as the latter speed for screw cutting. When the nature of the work makes it necessary or desirable, Bogert's improved elevating tool post or Bogert's improved compound rest may be applied to the top of the cross-slide, without any change in its construction. Tapers up to 4 in. to the foot can be readily and accurately turned with Bogert's improved taper turning attachment, without disturbing the alignment of the centers. This device must be provided for in the construction of the lathe. The bed, owing to a proper distribution of metal, is stiff and rigid, its design and arrangement of cross bracing being the result of the careful thought and experiment of years. In 1882 Mr. Bogert made the first drawing for a machine tool, with its bed deeper in the middle than at the end, and in 1885 tapered the ends, and at the same time brought the legs nearer together. His uniform practice in the case of lathes is to make the inside edge of the upper surface of one of the legs plumb with the front end of the head stock, and locate the other leg the same distance from the other end of the bed. An elliptic curve to the lower edge of the middle portion makes the elevation symmetrical, and best provides for the strain of use.

PROFESSOR LANGLEY'S AIR SHIP.

THE Washington *Post* of March 13 has published a long account of a "New Flying Machine," which it says Professor Samuel Pierpont Langley, of the Smithsonian Institute, has been secretly constructing and experimenting with for nearly two years. How much of this report is correct and how much is a consequence of the exercise of reportorial imagination it is impossible now to know. The following abstract of this highly colored account is given for what it is worth:

"The machine is a working model. It is not intended to carry passengers. In configuration the body portion closely simulates a mackerel. The backbone is a light but very rigid tube of what is technically known as 'title metal,' one of the many alloys of aluminium and steel. It is 15 ft. in length and 2 in. in diameter. To give rigidity to the skeleton, longitudi-

nal ribs of stiff steel are provided, intersected at intervals by cross ribs of pure aluminium, the result being a lattice framework of great strength.

"The engines, which are located in the portion of the framework corresponding to the head of the fish, are of the double-oscillating type. They weigh 60 oz. and develop 1 H.P., the lightest of that power ever made. There are four boilers of thinly hammered copper weighing a little more than 7 lbs. each, and they occupy the middle portion of the fish. Instead of water, a very volatile hydrocarbon is employed, the exact nature of which is a matter of secrecy, but which vaporizes at a comparatively low temperature. The fuel used is refined gasoline, and the extreme end of the tail of the fish is utilized for a storage tank with a capacity of one quart. Before passing on to the boilers the gasoline is volatilized by going through a heated coil.

"There are twin-screw propellers, which would be made adjustable to different angles in practice, to provide for the steering, but which in simply a working model are necessarily fixed at a certain point for a given trial. Screws of various pitches, and ranging from 20 to 80 centimeters in diameter, have been experimented with, but it is not yet definitely determined which shall be adopted for trial. With the smallest, the engines develop a speed of 1,700 revolutions a minute. With the larger ones the speed is somewhat decreased.

"A thin jacket of asbestos covers the upper portion of the body of the fish. It is unusually porous, and probably is employed to prevent undue loss of heat by radiation. The wings or aeroplanes are sector shaped, and consist of light frames of tubular aluminium steel, covered with China silk. The front one is 42 in. wide in the widest part and has an extreme length of 40 ft. from tip to tip. The rear one is somewhat smaller. Both aeroplanes are designed to be adjustable with reference to the angle they present to the air. A tubular mast extends upwardly and downwardly through about the middle of the craft, and from its extremities run stays of aluminium wire to the tips of the aeroplanes and the ends of the tubular backbone, and by this trussing arrangement the whole structure is rendered exceedingly stiff.

"The machine was constructed and perfected to its present degree in a secret room in the Smithsonian Institute, where it now rests. It was conceived about twenty months ago by Professor Langley, who associated with him in the work of experimentation Chief Clerk W. C. Winlock and Dr. Kidder, a scientific expert employed at that time in the institution. Four skilled workmen in mechanics and metallurgy were put to work under pledge of secrecy. The work went on at odd hours, mostly at night and on Sundays.

"An out-door trial has been planned. The intention is to employ a tug to tow the experimental party to a creek about 45 miles down the Potomac, where the experiments may be conducted without fear of interruption.

"In the large lecture-room of the National Museum Professor Langley has succeeded repeatedly in producing successful flight by small models. They would fly as long as the power lasted, the power being applied by means of lightly wrapped rubber bands, on the principle of the string top. The lightest of these little models weighs 16 grammes, and will soar from one end of the room to the other as freely as a bird.

"Professor Langley went to France, and while in touch with the most advanced investigators there he is believed to have reached his conclusion as to the best model for the general conformation of the proposed air craft—namely, the long, thin, tapering lines of the mackerel."

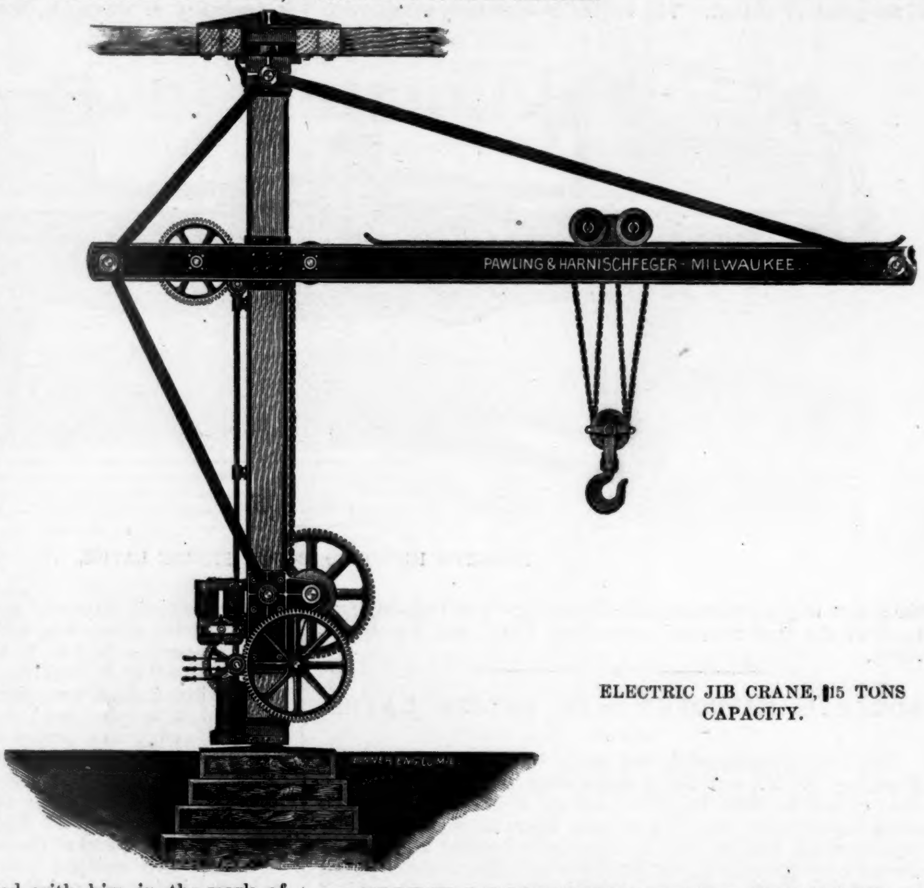
[There is a fishy flavor about this account which is disturbing to one's credulity.—EDITOR AMERICAN ENGINEER.]

A NEW SHOP CRANE.

THE accompanying illustration shows a jib crane of excellent design, made by Messrs. Pawling & Harnischfeger, of Milwaukee, Wis. This crane has a capacity of 15 tons; it has a clear lift of 18 ft. and a radial swing of 21 ft., enabling it to cover a floor space 42 ft. in diameter, or nearly 1,400 sq. ft. of floor. The jib is composed of two 20-in. steel beams, and the heaviest steel eye-bars forming the tension members have a net section of 4 sq. in. each, and receive a maximum stress of less than 15,000 lbs. per square inch. All the gears are cut from solid metal, and the pinions, in all cases, are cut from the best grade of machinery steel, thus insuring strength, durability and safety.

The shops of this firm have several of these cranes under construction for shops and foundries in Milwaukee and elsewhere, besides several of similar pattern and smaller capacity.

These works have also just shipped the first of three large armature lathes for the Siemens & Halske Company. These are specially designed for turning and finishing armatures from 10 to 16 ft. in diameter.



ELECTRIC JIB CRANE, 15 TONS CAPACITY.

AUSTIN LOCOMOTIVE STONE BREAKER.

MR. A. B. AUSTIN, of Fort Wayne, Ind., has recently put upon the market a locomotive stone breaker, which is intended to break stone along the track and deposit it in the form of ballast where it is needed. It is arranged with a single pair of drivers, which gives it the necessary adhesion for not only moving itself, but also for hauling one loaded car. It will run 30 miles an hour, and is so arranged that it can be changed from a locomotive to a stone breaker in five seconds by raising the drivers off the track, and it is guaranteed to break from 25 to 30 cubic yards of stone per hour on the main track or in the quarry. The rock for ballast can be handled in large lumps, loaded on flat cars, and drawn to the place where it is to be used as ballast.

The method of operation is to load and distribute this heavy rock along the side of the track where it is needed, and then take the machine to the spot and throw the large pieces into the breaker, thus doing away with the necessity of handling the broken stone with shovels. When in use the driving-wheels become the fly-wheels of the engine, and give the requisite steadiness of motion to the crusher. It would seem that there are many places in which such a machine would prove valuable and efficient.